This war will be won or lost by education. It is a war of technicians and machines and only the schools and colleges can supply the technical training which every man in the armed services needs.
—W. H. PILLSBURY.

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VOL. XLIII MARCH, 1943 WHOLE NO. 374

WEAKNESS IN PRESENT DAY ARITHMETIC PROGRAMS*

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When the chairman of your section invited me to participate in this program I submitted the topic, "Constructive Trends in the Arithmetic Program." On receiving my copy of the association's program I found that, in accordance with the convention's central theme, the topic had been changed to "Weakness in Present Day Arithmetic Programs." I am quite willing to use the topic assigned, but I hope that my paper will not result in purely negative criticism. Rather, I hope that the outcome of this discussion will be some constructive improvement in the teaching of arithmetic.

In this paper I shall discuss five weaknesses in arithmetic. The first, and one of the most significant weaknesses, is the failure to appreciate the value of an *abstract* use of number in meeting the needs of life. My emphasis here is on the term *abstract*,—an emphasis which may require some explanation.

Concrete and Abstract Uses of Number

A child's understanding of number always begins with concrete experiences and is frequently described as a one-to-one relationship. For example, if a young child is asked to divide 9 pieces of candy among two friends and himself, he will do it concretely by saying: one for you, and one for you, and one

* Presented at the Elementary Mathematics Section of the Central Association of Science and Mathematics Teachers, November 27, 1942.

for me; one for you, and one for you, and one for me, etc. When he has finished he will be confident that each child has an equal number of pieces of candy, but he may not be able to say that each child has three pieces. The concept that 9 can be divided into 3 groups of 3 each is an abstraction that comes later in the child's experience.

Likewise, in counting, a young child may learn to say the number names in serial order long before he can do true counting of objects. True counting will be done by touching or pointing to the objects in serial order as he counts them. Later he can count abstractly without having the objects present and still have a full sense of the numerical meaning of what is done.

In learning number combinations a child may be taught to say by rote that $3+2=5$, and yet understand nothing of the relationship involved. Or he may begin with concrete experiences in which he finds that 3 books plus 2 more books does equal 5 books, a fact which he can verify by counting them.

It has now been widely accepted that a child's abstract practices with number should follow rather than precede his concrete experiences. Consequetly it is now general practice to begin the teaching of arithmetic with much concrete experience, letting the abstract relationships grow out of the understanding of the concretes. This methodology has given much more meaning to the number experiences of children. All American textbooks lay great emphasis on the early concrete number experiences of young children.

This emphasis on the concrete as a necessary preceding condition to the abstract has brought great gains to arithmetic. It has already stopped, in a considerable measure, the practice of two decades ago of having children drill on abstract number combinations before they had any concrete experiences to convince them that the abstractions were actually true. It has put a stop to the previously common practice in the middle and upper grades of beginning with a rule that was memorized without understanding and then applying it to problem situations. However, along with this signal gain in meaning, which has been attained by emphasizing the concrete as a prerequisite to the abstract, there has come a tendency to stop with the concrete and never to arrive at significant abstractions which are really the essence of arithmetic.

An abstraction is a generalization that grows out of concrete experience. The value of abstractions in arithmetic is due to

their great convenience in short-circuiting the awkward process of using concretes in our thinking. At heart, arithmetic is a system of abstract relationships which may give a far higher proficiency to number experience than will ever be possible by the simpler and cruder processes of concrete reasoning. It is just as important that arithmetic *carry through* to the point of abstraction as that it *begin* with with the point of concreteness. A failure to carry through leaves pupils without the essential tool which arithmetic can contribute to their quantitative thinking.

The development of abstract concepts in arithmetic requires careful planning. These concepts are seldom arrived at incidentally. Furthermore they are not likely to be attained in a program of arithmetic that grows out of chance everyday needs as contrasted with a program of arithmetic that focuses its whole attention upon developing important abstractions. For example, in upper-grade arithmetic the concept of the relationship between the circumference and the diameter of a circle, ordinarily described as π, may be taught in several ways. One of the common old ways was to begin with the fully developed abstraction that π, the ratio of the circumference to the diameter of a circle, is 3.1416 or approximately $3\frac{1}{7}$. If children memorize this they may be able to use the fact as occasion demands but if they forget the exact number they have no technique for getting it back. Nor do they know why it is true. In fact most children would be quite as willing to accept as the value of π $4\frac{1}{7}$ instead of $3\frac{1}{7}$ if the teacher told them that this were the fact.

Another method of teaching would be to pay no attention to the value of π as an abstract fact, but to instruct children that whenever they experience the need of finding the ratio of the circumference to the diameter of a circle they measure and see what it is. This of course can be done, but under such a form of teaching many children will never sense the fact that whatever the size of the circle the relationship is always the same. They will have to deal with each concrete experience as though it were a separate entity and start at the beginning as though they had never had the experience before.

A still better method would be for a teacher to plan a unit to give understanding to this relationship between the circumference and the diameter by asking children to bring to the school room a number of circular objects. When the children bring in tin cans, ink bottles, silver coins, milk bottle caps, or

what not, the relationship between the circumference and diameter may then be translated from the concrete to an abstract concept. By careful measurement the child will find that the circumference of an ink bottle is approximately $3\frac{1}{7}$ times its diameter. Likewise the child with a tin can will also discover that, regardless of the size of the can, the circumference is $3\frac{1}{7}$ times the diameter. Children bringing other objects of various kinds and sizes will discover the same general fact. When these facts are listed on the blackboard the pupils will be able to see that the value we call π is true for all circles. They then have arrived at a general abstract truth of wide applicability. They have now learned that for any circle, of any size, at any place, and at any time the circumference will always be $3\frac{1}{7}$ times the diameter. Here is a general truth that is of universal value. Furthermore if they forget that the formula is $3\frac{1}{7}$ they will remember that they can derive it again by measuring any circle, since the ratio of the circumference to the diameter of *any* circle is always the same. This is what I mean by an abstraction. An abstraction is of such general value that in this case it will apply to all experiences where the circumference and diameter of a circle are in question.

The essence of arithmetic is the series of abstract truths which it presents. If a child can be led to understand that arithmetic gives a series of abstractions that are useful wherever he is, he will begin to sense that the subject is important for him. Most children understand that 5 of anything plus 6 of that thing equal 11 regardless of when or where the experience occurs. Most children accept the abstract number facts as universally true. However, the abstractions that go beyond the number facts are much less clearly understood and many times a child never carries his learning to the point where the abstraction is really his own. One weakness of arithmetic is its failure to give to every child these essential abstractions.

All of the abstractions in arithmetic reside in the fact that our number relationships spring from a number system and that to really understand them one must understand thoroughly how the system operates. Our number system is built on *ten*. While it might conceivably be built on any base, as long as it is a decimal system the importance of ten in that system must be understood, so that the child may obtain full value from the abstractions which this system makes possible. The understanding of the ten basis of our number system is fundamental to

understanding borrowing and carrying. It is fundamental to understanding why our computational processes are as they are. Yet many children go all the way through the elementary school without sensing that there is a number *system* and that *ten* is the pivotal factor in it.

In the upper grades it is important to illustrate to children how a number system operates by showing how one might operate on some base other than ten. When children try to count or to add and subtract with a non-decimal system they become much more aware of the characteristics of the decimal system as a system. We in America have taught the number system much less well than have the schools in England and continental Europe. We are still afflicted by the demand that arithmetic deals with practical experiences rather than with general abstractions that have wider possibilities of application.

Significant Social Applications

A second weakness in our arithmetic program springs from our lack of ingenuity and insight in devising socially significant illustrations which will give to arithmetic interesting and meaningful relationships with life experiences. Arithmetic is the application of an abstract number system to the varied quantitative situations that one meets. These applications may be sterile and dead or they may deal with significant social needs. The abstractions of arithmetic are the same at all times and for all situations, but the applications may be as modern as the needs of today. The processes of long division are the same whether they are applied to measurements relating to the extinct dodo bird or whether they deal with the most pressing problems of a modern community, but certainly the school should choose the latter type of applications. The common criticism of arithmetic, that it is a dry, sterile subject, is due primarily to the fact that teachers are using dry, sterile applications in the problems and exercises of arithmetic. There is no such thing as sterile number relationships. These will always be the same.

Any textbook in arithmetic, or any other subject for that matter, suffers from the fact that its illustrative materials, that is, its applications, necessarily become out of date and at best can never touch the special and varied interests of every child. There are still wide differences in the social significance of the applications of arithmetic. All authors of textbooks face the

difficulty of abandoning worn out social applications simply because of the insistence of many people that the particular applications which they learned are a necessary part of an arithmetic program, regardless of their meaningfulness to children. The best that any textbook can do is to try to draw the illustrative material for its verbal problems from significant and interesting human experience rather than from worn out situations. However, there will always be a need for individual teachers to supplement the textbook with applications that are particularly pertinent to the children in a particular class and in a particular community. This does not mean that the mathematical content of arithmetic be modified according to individual needs of children but that the teaching be so planned that the essential concepts of arithmetic be presented in situations that appear to be vital and important to the learner. The processes of borrowing, carrying, adding, or dividing will be exactly the same regardless of whether the vehicle for presenting them is formal and lifeless or is significant and interesting, but what many persons describe as the formality of arithmetic is due solely to the lack of ingenuity and imagination of teachers and textbook authors in presenting number relationships in a context that is vital and important.

In a world undergoing such rapid change as characterizes the present age it is imperative that arithmetic vitalize its material and show that its essential mathematical content can be expressed in socially significant situations. For example, we are now hearing much about new problems created by an expansion of air travel. With airplanes laying out routes following the shortest direct distance, our geographical concepts are being rapidly modified. Children who have never seen any direct value in studying the characteristics of the surface of a sphere are now finding a new interest in what is termed "great circle" routes. It is a striking experience for most children to discover the difference in the shortest distance as measured on a flat map as contrasted with the shortest distance as measured on a globe between such points as Chicago and Tokio or Chicago and Leningrad or Australia. Not only has the new air age changed our concepts regarding routes of travel and distances covered, but it is also modifying our concepts of rate and time. Only this week the newspapers reported that a plane had flown from the United States to New Delhi, India in 67 hours of elapsed time

or 60 hours of flying time. All of us can recall that only 15 years ago this was the amount of time required by the fastest trains to go from Chicago to California. The teaching of measurements can be made immensely interesting if teachers will see in the world of today the possibilities of interesting applications to supplement those given in textbooks.

In the last decade the problems of farmers and farm children have varied enormously from those of two decades ago. The reports which the government has required farmers to submit in order to receive crop benefits furnish fine opportunities for arithmetical applications. These problems make use of the same mathematical facts and processes as do any other problems, but the rural child feels his status on the farm raised considerably by the fact that his arithmetic ability enables him to help his father fill out reports that are actually important. There is no reason why, in rural communities, much of the arithmetical work of children should not be related to farm applications. In the *long* run the mathematical training will be the chief value obtained from this work, but in the *short* run the social significance of the applications will seem most important to the children. This is as it should be.

New sales and federal taxes furnish other opportunities for significant applications of arithmetic. Much practice in percentage may be derived from computing and checking the additional tax cost of items ranging from tickets to the movies to the staple purchases in any home. Probably no age has ever been as replete with possibilities of socially significant applications of arithmetic as the present. What is needed is imagination in seeing these possibilities. In this connection it is highly important that teachers be perfectly clear about two facts: first, that the concrete problems used for applications in arithmetic are only the vehicle for teaching the essential mathematical content of the subject; second, that the mathematical abstractions, facts, and processes used in these applications are the essential factors which arithmetic aims to teach. Applications must be significant, timely, interesting. Hence, they must change from time to time and from community to community. They give life and vigor to arithmetic. But number relationships and processes are enduring, are of value at all times, are ever the same. There is no need for a new copyright date for the multiplication table.

Arithmetic and Personality Development

A third weakness of our arithmetic program arises from the fact that, particularly during the past decade, there has been a *de-emphasis* of arithmetic due to a supposed damage to personality that is an outcome of arithmetic. In some communities this supposed damage to personality has resulted in a stopping of the teaching of arithmetic as a systematic body of content and has substituted for it only the incidental experiences with number that arise in a child's normal experiences or in the special projects and activities sponsored by the school. As has been pointed out earlier, the essential content of arithmetic is its number relationships which are not mastered through casual number experiences. Both psychologists and teachers are now becoming increasingly clear that the supposed harm to personality development was a pure illusion based on assumption rather than fact.

Personality development arises from the ability of an individual to adjust successfully to frustrations. One of the commonest forms of frustration results from lack of ability to meet quantitative number situations. The feeling of security that a mastery of arithmetic gives is one of the positive assets to personality. The difficulty here is not due to the fundamental content of arithmetic but rather to the formal applications through which this content has been presented. It is quite possible to present arithmetic as a system of number relations through stimulating social applications that will be vivid and meaningful to the learner, and which will make a positive contribution to those characteristics that give balance and strength to personality. It is like throwing out the baby with the bath to de-emphasize arithmetic because of the formal applications that are frequently used in presenting it. Fortunately the negative results from this de-emphasis have now passed their crest and seem definitely on the wane. However, it has retarded the development of a good arithmetic program in many schools and has produced confusion in the curriculum that will require a school generation to overcome. It furnishes a pertinent example of the way education may be set back by the leadership of a pressure group that is guided more by sentiment than by scientific data.

Non-computational Values of Arithmetic

A fourth weakness in our arithmetic program is the failure to

see the non-computational uses of arithmetic, particularly as related to reading and to quantitative thinking. The ordinary textbook is too often merely a work manual. In addition to the accepted emphasis in textbooks on computational exercises the situation has been rendered still more serious by the use of supplementary workbooks that have frequently been little more than additional practice exercises in computation. I certainly do not mean to imply that accuracy in computation is unimportant. I believe quite the opposite. But the weakness in this respect is failure to emphasize sufficiently a value that is of equal importance with computation. There ***has been*** progress in emphasizing non-computational arithmetic but the subject is still weakened by a shortsightedness in sensing the possibilities of the non-computational outcomes of the subject. When a textbook devotes two or three pages to reading material replete with quantitative terms and numbers but without pencil and paper exercises, the criticism encountered is that on these pages there is nothing for the children to do and that there should be exercises on every page. This notion that children do nothing arithmetically when they read seems to be altogether too common. In spite of the emphasis which three national committees have given to the importance of non-computational arithmetic the idea has been slow in spreading. And yet in ordinary life experience the number of occasions that one uses arithmetic in his quantitative thinking is far greater than the number of times he uses computation. It is a weakness in our arithmetic program that we do not recognize as of major importance the training of children to think quantitatively as they read and to improve the quantitative approximations that are used in thinking. This would help them greatly in their critical responses to what they read and in their thinking. There are far too many people for whom the addition of a zero or two at the end of a number will be read with no perceptible difference in their mental response. The difference between 100,000,000 and 1,000,000,000 in a new tax measure makes no noticeable difference in their thinking concerning it.

A critical reading of quantitative comparisons would be of value not only for reading outside of school but it would certainly be appreciated by teachers of social and natural sciences in school. The point which I wish to emphasize is that training in reading critically, where numbers and number comparisons are involved, is an important part of the obligation of arith-

metic. Furthermore, training in careful quantitative thinking where pencil and paper computations are impossible is a necessary obligation of the subject. These abilities do not arise automatically from teaching which emphasizes only practice in computation. Schools have suffered too long from the concept that arithmetic is simply a skill subject.

Limitations Due to Narrow Applications

A fifth and last weakness that I shall mention is due to the limitations in the arithmetic program which grows out of trying to derive all arithmetical experiences from the child's personal problems or from the problems of his immediate community. This is a weakness that is likely to be aggravated temporarily due to the present emphasis on the problem approach in all curriculum fields and to the present emphasis on the community school movement. The weakening of the program of arithmetic can be avoided by clear thinking about the values and limitations of both of these proposals.

The proposal that school work should grow out of pupils' own problems or needs is an effort to capitalize on children's present interests and to give stronger motivation to school work. This aim is completely laudible. It is without question important that learners be interested in what they do. There will probably be universal agreement among teachers that in the beginning stages of any learning, greater interest can be aroused if what is to be learned is related to the problems or needs of the learner. One may grant that this is a desirable way of beginning without granting that it is necessarily a determiner of the entire sequence of learning. The issue goes back to the matter previously discussed of the relationship between the outcomes of arithmetic and the vehicle through which these outcomes are presented.

The essential contribution of arithmetic is a mastery of the abstract relationships among numbers. When this can be presented through applications directly related to the child's own problems there is every advantage in doing so. However, it is seldom that the child's immediate interests will go far enough to facilitate a systematic presentation of arithmetic throughout the elementary school program. It then becomes the obligation of teachers to interest children in what is important for them to be interested in. This in most cases will mean to carry the subject far beyond the pupil's personal problems and even be-

yond the problems and needs of his own community. Situations through which arithmetic may be taught incidentally may serve as excellent applications for the subject but the fact remains that arithmetic is a complete system. One cannot select at random items from a system and expect to get the benefits which an organized system makes possible. Arithmetic is based on a completely related and integrated number system. Its parts are interdependent. There is a sequence in its learnings proceeding from simple to complex; from immediate concretes to widely applicable abstractions. Some parts of arithmetic will not be related to the immediate needs of all children or even of their community. Some parts are essential to future needs. The War Department is now making frantic efforts to remedy the gaps left in a mathematics program of many of its recruits by schools which never foresaw the uses to which its pupils might sometime put their mathematics and omitted such training because their own individual problems or the needs of their local community gave no evidence that such general understandings of mathematics would eventually be required. One of the weaknesses of the community school movement is in not seeing farther than the end of the community's nose. The strength of the movement is in the vitality of the applications arising from one's own community life. This strength will be of little avail if the strategy of education limits the activities of a school to the immediate needs of individuals or local communities.

Summary

In this paper I have emphasized *five* weaknesses in our arithmetic program and have shown directly and by inference some possible corrective measures that the school might undertake. To summarize, these weaknesses are: first, a failure to appreciate the value of an abstract use of number which results from a confusion of the functioning of concrete and abstract forms of experience; second, a weakness due to lack of ingenuity and imagination in devising socially significant applications for teaching the essential abstractions of arithmetic; third, weaknesses due to the de-emphasizing of the program of arithmetic during the last decade on account of the supposed harm that this subject might do to personality development; fourth, weaknesses due to the failure of teachers and curriculum makers to see the non-computational values of arithmetic, particularly in

reading and in quantitative thinking; and fifth, weaknesses due to limitations in the arithmetic program resulting from restricting arithmetic to the child's own personal needs and to the needs of a local community.

A KINEMATIC PARADOX

ARTHUR B. HUSSEY
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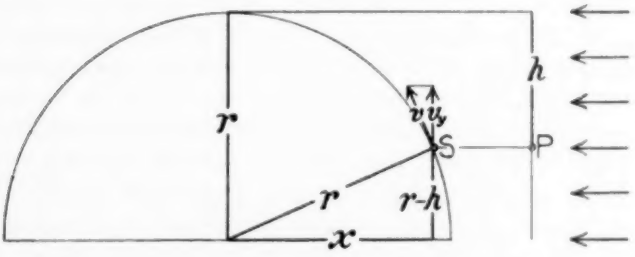
Marooned on Mt. Washington during a two-day blizzard in July, a party which had taken refuge in the hut at the Lakes of the Clouds amused itself with puzzles, paradoxes, and "problems involving ingenious methods." The young men who act as hosts at the hut, college students, took an active, interested part in the fun. One of them described a physical example of the evaluation of indeterminate forms which had been used by his instructor at "Tech." It seemed so paradoxical and ingenious to a member of the group that he has been tempted to strip it of the paraphernalia of the calculus in which it was presented, and give it in a form which requires only an elementary knowledge of the motion of falling bodies, and simple algebra, for its statement.

The paradox is that a stationary object can, with proper arrangement, cast a moving shadow. Light source and surface on which the shadow is cast are at rest, and there are no "hidden mirrors"!



In the figure, P is a particle thrown vertically upward beside a hemispherical dome with initial velocity such that it rises just to the level of the highest point of the dome. The sun is casting a horizontal beam, as shown by arrows at the right, so that the shadow, S, of P on the dome is always at the same height as P.

Let h = the vertical distance from P as it rises, to the top of its motion, and other quantities be designated as in the figure. Denote the velocity of the particle by v_y, and the velocity of its shadow by v.

As for any free body acted on by gravity,

$$v_y = \sqrt{2gh}. \tag{1}$$

v_y is vertical; v is tangent to the surface of the dome. Hence

$$v : v_y = r : x = r : \sqrt{r^2 - (r-h)^2}$$
$$= r : \sqrt{2rh - h^2}.$$

$$v = \frac{rv_y}{\sqrt{2rh - h^2}}, \qquad \text{which, by Eq. (1),}$$

$$= \frac{r\sqrt{2gh}}{\sqrt{2rh - h^2}}.$$

$$v = \frac{r\sqrt{2g}}{\sqrt{2r - h}}. \tag{2}$$

When $h = 0$, P is at the top of its path, and its velocity, $v_y = 0$. But from Eq. (2),

$$v = \frac{r\sqrt{2g}}{\sqrt{2r - 0}} = \sqrt{rg},$$

which is not zero.

For example, if distances are in feet, and $g = 32$ ft/sec^2, the speed of the shadow on a dome of radius 8 feet is $\sqrt{8 \cdot 32} = 16$ ft /sec, when the object casting the shadow is at rest at its highest point.

GLASS-LINED MOLD FOR CASTINGS

Using glass as a part of a mold into which liquid metal is poured to make a casting may seem a bit startling at first; but this is what is done in the invention on which Joseph S. Brazil of Detroit has received patent 2,304,879. In some kinds of hollow castings, like artillery cartridge cases, the interior must be smooth, yet the mold core cannot be taken out whole. Ordinary sand cores always leave the surface rough, necessitating extra operations and added expense to smooth it. By covering a permanent core with a layer of glass, Mr. Brazil provides the kind of surface required. The glass covering is easily manufactured and cheap, so that there is little loss when it is shattered. It would even be possible to send the broken glass back to the manufacturer to be re-used, if desired, he points out.

THE STORY OF BLOOD TRANSFUSIONS

MARIE C. CLAIR
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The headlines in newspapers and magazines of our day feature death and destruction. They speak of millions of the nations' best young manhood locked in fierce combat in the air, on land and on sea. Factories and shipyards work feverishly to turn out machines of destruction. Human life seems to be considered of little or no value beyond the operation of guns, tanks, torpedoes and bombs except to the families of the young men who constitute the vast millions of the fighting armies. However, civilized man has not entirely snuffed out the spark of sympathy and mercy. True, war cannot be humanized, its very inception and plan is death and destruction, but woven into its pattern of tanks, bombs and shells is the sign of the cross, under whose shadow operates the medical corps. Its activity represents mercy, lessening of suffering, and above all, a helping hand to the vast numbers of our heroes classed as wounded. A mighty legion are these workers of mercy, and ceaselessly they labor to rob death of its "after the battle" preventable toll of human life. The tactics of war change and so do the aids and methods of the medical science. Perhaps one of the most successful modern medical discoveries to reduce "needless" death on battlefields is *blood transfusion*. These two words no longer sound strange and new to us, for even in times of peace countless lives are saved by this method.

Blood transfusions date back to the early seventeenth century (15). A few hundred years ago people knew very little about the substance which circulated through their veins, which kept their heart in action and their body alive. But then as now, men labored ceaselessly to learn more about life and things necessary to keep it in the tissues of the human body. Great excitement heralded the discovery by William Harvey that blood was the important substance which supplied our body with the necessary things to keep us alive, and that it circulated in a very definite manner (15). This discovery was the incentive for many other discoveries and experiments. One of the most significant was what is now called blood transfusion.

For about ten years following the discovery experiments with it were limited to animals. The main concern was to find out the best way to administer a transfusion. In 1665 the first successful

recorded transfusion was made by Richard Lower. He took blood from the carotid artery of one dog and injected it through a series of connected quills into the jugular vein of another. Later a silver tube was used to make possible the transfer of blood (12). About this same time the first transfusion of blood to a human patient was tried. The physician to Louis XV performed this operation on a 15-year old Parisian boy by transferring a pint of lamb's blood into the veins of the boy who was exhausted from repeated bleedings, and he recovered (12). Sensational as this operation appeared, blood transfusion was by no means universally successful, for deaths followed similar treatments on other patients. Opposition to such operations grew stronger because of the severe reactions which followed blood transfusions, and also because of frequent poor diagnosis of disorders requiring such treatment. In 1687 an edict by the church and parliament prohibited animal to man transfusions (15). Such opposition discouraged men of medicine to continue their research in this field and transfusions were forgotten for a period of about 150 years. But science had a revival and with it the study by the experimental procedure to discover truth. James Blundell, an English obstetrician, searched for a treatment which would reduce loss of life among mothers from hemorrhage at childbirth. He brought blood transfusions back into the limelight, but expressed the conviction that only human blood could safely be injected into humans (12). He devised an apparatus into which the donor could be bled and from which the blood could be forced into the recipient's veins (12). He discovered that venous blood was as good as arterial blood, and that it did not lose any of its beneficial properties by being passed through the apparatus (12). He also found that it was necessary to restore blood in an amount equal to the loss. In 1818 he began to put his discoveries into practice on his patients. At first there were a few failures but success followed. Infections were counteracted by antiseptics whose discovery are credited to Pasteur and Lister. With the aid of antiseptics surgery was made more safe and reliable. By 1859 blood transfusions were successfully carried out in 45 out of 57 cases (12). Studies of the problems associated with such operations were continued and new discoveries were made. In 1821 experiments were carried out to prevent the clotting of blood by removing the fibrin or by adding caustic soda to make it inactive (12). These treatments were not successful but search continued. In 1869 it was found

that serum of one type agglutinated and dissolved the corpuscles of another type (12). In 1900 an Austrian scientist, Karl Landsteiner, proved that not all human blood was the same, and that the wrong type of human blood might be as harmful to a patient as blood taken from animals. After two years' experimentation four main blood groups of human beings were recognized, viz. O, the universal type, A, the type found in the greater number of people; B, found in the lesser number of people; and AB, the most unusual type (12).

There still remained the problem of safe transfer of the blood from donor to recipient. At first syringes were used. This necessitated a speedy transfer, because if the blood came in contact with the air it would clot (12). In 1900 it was discovered that only the lining of the blood vessels could come in contact with the blood without causing coagulation. 1905 marks the year when surgeons first performed the difficult task of transferring blood through the vessels (12). But donors were few because it meant an operation for both persons involved, and in some cases there was also the danger of contracting the disease of the patient. In 1911 blood was collected in a paraffin-coated vessel which delayed clotting long enough so that blood could be carried from one room to another, hence, donor and recipient needed not to be in the same room. In 1914, and throughout the first world war, sodium citrate was added to the blood to keep it from clotting (12). Obtaining donors was a difficult problem, and the fees asked were usually almost prohibitively high, ranging up to fifty dollars a pint. Agencies were organized but these were soon driven out of business by the health authorities. In 1929 the Blood Transfusion Betterment Association was organized. It set up certain requirements to be met by donors; the rules and regulations set up at that time are still governing today. Donors had to be registered with the Department of Health, and be free from any communicable disease; they had to have a hemoglobin content of 85 percent, show normal weight and blood pressure, and a negative reaction to the Wassermann test. The price fixed for blood was seven dollars per hundred cc. (15).

To-day we recognize two important forms of blood usable for transfusion, each of which has its advantages and disadvantages. The first is whole blood, which is really the best substitute for the blood lost (8). It contains the oxygen-carrying hemoglobin in its red corpuscles and for this reason it is preferred

especially in cases of anemia and carbon monoxide poisoning. In these diseases the red corpuscles have been damaged. But use of whole blood involves several difficulties which are not easily overcome. In the first place it has to be typed because of the agglutination and destruction of red corpuscles when two different types of blood are mixed. This involves time and money which are obstacles in an emergency. It is also difficult to transport since each type of blood must be kept in a separate container. Another problem is that whole blood deteriorates with age and induces unfavorable reactions in the patient (27). It can, however, be held for thirty days if it is mixed with sugar and sodium citrate, but medical men prefer a form which is more reliable, and discovered this feature in blood plasma. Blood plasma is a boon to the wounded soldiers on the battlefield. In most cases it is superior to medicine and light treatment. It contains all of the important protein elements in a form ready for immediate assimilation; it increases volume and raises blood pressure; it increases power of coagulation, thus reducing loss by abnormal bleeding. In case of chronic infections it replaces the lost blood and stimulates formation of antibodies (14). Blood plasma is the simplest and surest medicine to administer in emergency. All preparatory work can be completed days, months and even years before it is used. It requires no typing because the red corpuscles, which cause agglutination when two different types of blood meet, have all been removed. There is nothing in the plasma to cause an unfavorable reaction in the recipient. The plasma from one person can be mixed with the plasma from any number of other people, and these can all be pooled for later use. We call this process blood plasma banking. The first blood bank was formed in Chicago in 1937 (15). Since then, success with them has gradually increased until today the American Red Cross is preparing the largest reservoir of plasma in the history of the nation. It will contain 10,000 units of dried blood equivalent to 10,000 pints of blood (1). Plasma in this form has been kept up to nine years (7). 500 cc. of blood are taken from each donor and put into a collecting bottle. When these bottles reach the laboratory they are handled in a room which has a constant temperature of thirty-four degrees Fahrenheit. The bottles are placed into a centrifuge which has a speed of 2500 revolutions per minute. When they are removed the plood plasma is on the top and the red solid material is at the bottom (1). Each bottle of separated blood

then goes to a "pooling room," where the plasma is drawn off the top into a glass cylinder. The plasma is now ready to be tried out on animals to see if it has any toxic effects. It is also examined before freezing to make sure it does not contain any foreign matter (1). In order to dehydrate the plasma, an ampule of it is placed on a geared spindle which rotates in a trough of dry ice. Following this it is set into a dehydrating machine where a vacuum pump operates for seventy-two hours to remove all water, leaving only a dry, flaky powder which contains all the essential elements of blood (1). This powdered plasma is corked under a vacuum and the neck of the glass ampule is sealed. After labeling it is stored. In this state it will remain stable in any climate for an indefinite time (1). We can readily see, too, that plasma thus prepared can very simply, quickly and effectively be transported to any place where it is needed. Plasma can be redissolved to whatever concentration is required, making it invaluable in certain cases of shock where too much blood leaves the vessels very suddenly (11). Plasma is truly the live-saver of the wounded soldier. It is the reliable transfusion that is used all over the world in time of war. It does not have some of the qualities of whole blood, such as carrying oxygen to the cells, but these qualities are not the most important in an emergency. If time is not a vital factor it is best to use whole blood, but where help is urgent plasma very efficiently serves the purpose.

Sometimes it is impossible to give blood transfusions through the veins. Severe mutilations, burns, dropsy, shock, and poorly developed or obliterated veins are conditions in which transfusion through the bones is helpful (9). Blood is injected into the marrow of the bones, particularly the breast, collar, thigh and shin bones. In these bones blood cells are formed and then make their way into the blood stream. They enter the blood stream apparently unchanged and almost as rapidly as when injected into the veins (9).

An experiment dealing with treatment of beef blood to make it suitable for transfusion into the human body has recently been performed at the University of Minnesota Medical School in the interest of blood transfusion. Before being used, the beef blood is treated with human red blood cells, and absorption takes place. Because of this previous absorption there is no dangerous clumping or dissolving of the red cells in the patient's blood during the process of transfer (3).

The catastrophe at Pearl Harbor on December 7, 1941 pro-

vided the first large-scale application of transfusion. 960 casualties, the majority of which were either burned or wounded, were cared for in sixteen hours, or at the rate of a man a minute (21). Blood plasma was already on hand in a large mobile hospital before the attack occurred. Similar hospitals, equipped with an adequate supply of plasma, are found wherever our armies go, ready for any eventuality. In the Pearl Harbor catastrophe sixty per cent of the injuries were flash burns. These are burns in which only the flesh not covered by clothing is damaged (21). Sulfa drugs were administered first to prevent infection, and transfusion followed in the serious cases. Plasma is highly beneficial in the treatment of traumatic shock, which is common among civilians as well as soldiers. It is caused by burns, wounds from shrapnel, splinters and falling debris; it also frequently occurs after an operation (21). During such a shock the liquid flows from the blood vessels to the damaged tissues. Then the heart no longer gets enough blood to function properly. If blood is not injected, a person may actually "bleed to death" though no blood leaves the body (4). Plasma restores the volume and draws the fluid from the tissues into the blood stream. Plasma is also very valuable in cases of gunshot wounds (14).

Such are the problems which confront our doctors and nurses on the battlefield. We can almost hear them calling for blood and more blood. But to-day America is not letting this call fall on deaf ears. Blood is being sent in large quantities to all sectors where warfare is raging, and in our country to all areas where the enemy may strike. 55,000 persons have donated blood since Pearl Harbor, and the number is steadily increasing. The Red Cross has depots all over the country to receive blood donations. The Red Cross National Bank has 15,000 blood plasma units on deposit (7). To give our blood for this worthy cause is giving something which is essential to life, which is a part of life itself, and represents one of the most patriotic duties of every American citizen. Those boys are our soldiers, they are fighting our battle for freedom and liberty, and the least we can do is to protect their lives against preventable death with the contribution of an adequate supply of the life-saving blood plasma.

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A NEW RECORDER TO DETECT FLAWS

A new automatic recorder has been developed to detect flaws in engines and structures, such as aircraft. The recorder makes diagrams showing elastic qualities and internal friction of the object under test. If the diagram varies from the standard tracing for the object tested, there is a defect. Nature of the defect may be interpreted from the shape of the diagram. In principle this test is the same as the thousand-year-old test for detecting flaws in chinaware by striking the rim and listening to the resultant sound.

SIMPLE MAPPING FORMULAS

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Most of the maps ordinarily found in atlases and geographies are based upon one of three fundamental types,

A. the cylindrical
B. the conic
C. the plane.

These types derive their names from the surface upon which the face of the earth is "projected." The surface of a sphere can not be flattened out or unrolled into a plane, while the surface of a cylinder or cone, can be. Consequently, one way to make a flat picture or map of the earth is to first "project" the surface onto a cylinder or cone which is tangent to the earth, and then unroll the resulting map into a flat surface or plane.[1]

It should be emphasized that map "projections" are not necessarily simple straight line projections like those used in mechanical drawing. For many of the maps in common use, the earth's surface is "projected" entirely by a *mathematical formula* without reference to any straight lines at all. It is the purpose of this article to present some of the simpler formulas for map "projections" in the hope that teachers and students may find them of special interest at this time. While the derivation[2] of most of them requires even more advanced mathematics than Calculus, any student who has studied Trigonometry could use them to actually construct a map.

Before giving these formulas, let us consider four different classes of maps.

1. An *Equidistant Map* is one in which all distances along certain lines or from a certain point are true to scale.

2. An *Equiareal Map* is one in which every portion is represented in its true relative area.

3. A *Conformal Map* is one in which all angles are truly represented. It also represents approximately the true shape of any small portion.

4. The name *Simple Geometric Map* might be applied to one obtained by projecting the surface of the earth by straight lines from its center directly onto the cylinder, cone, or plane. This would be a simple straight line projection like those used in

[1] See *Life Magazine*, Aug. 3, 1942, pages 57–65.

[2] All formulas for Class 4 can obviously be derived by elementary methods.

mechanical drawing. We add this chiefly for comparison, since only one type is ever used. A map of each type is possible for each class, making a total of 12 different maps. There are, of course, other special maps which do not fall directly into any of these classifications. An ideal map would combine all the properties of Classes 1, 2, and 3, but unfortunately, such a map is impossible.

For the cylindrical type, we shall take the cylinder tangent to the earth at the equator. The meridians will then appear on the map as uniformly spaced straight, parallel lines. The parallels of latitude will be straight lines perpendicular to the others, but varying in their spacing. In writing the formulas for spacing these lines, we shall let u, v denote the latitude and longitude, respectively, of points on the earth, and x, y denote the ordinary Cartesian co-ordinates of the corresponding points on the flat map. Positive values of u denote north latitude, and negative values, south latitude; positive values of v denote east longitude, negative values, west longitude. The formula for each class of cylindrical maps is here given with the number corresponding to the class number.

A1	$x=v,$	$y=u$
A2	$x=v,$	$y=\sin u$
A3	$x=v,$	$y=\log_e \tan (\pi/4+u/2)$
A4	$x=v,$	$y=\tan u$

Of these, only A3 is of practical use, and this is the familiar Mercator Projection used by all navigators at sea. It is the one which gives people the impression that Greenland is as large as South America because it is not an Equiareal Map.

In the conic type of map, the meridians are straight lines radiating from the pole, while the parallels are all circular arcs with centers at the pole. The formulas for these maps are much more conveniently expressed in polar co-ordinates, r, θ, where r is the radius of the parallel of latitude u. We shall use a to denote the latitude at which the cone is tangent to the earth. The angle between the axis of the cone and any element is readily seen to be equal to a.

B1	$\theta=v \sin a,$	$r=\cot a+a-u$
B2	$\theta=v \sin a,$	$r^2=1+\csc^2 a-2 \csc a \sin u$
B3	$\theta=v \sin a,$	$r=C[\cot (\pi/4+u/2)]^{\sin a}$

where $\log C = \sin a \log \tan (\pi/4 + a/2) - \log \tan a$

B4 $\theta = v \sin a, \qquad r = \cot a - \tan (u - a)$

It should be noted that the angles of longitude around the pole are here diminished by the factor sin a. Of these maps, all but B4 are used. B1 is known as the Simple Conic Projection, and was used in the early days of world maps. B2 is essentially the Albers Equiareal Projection, and B3 the Lambert Conformal Conic Projection. These last two are used for maps of the United States.

For maps based on a plane tangent to the earth, we shall consider only the case in which the plane is tangent at the North Pole. We shall again use polar co-ordinates, and number the formulas according to the type and class. The meridians will be radial lines from the North Pole of the map, and the parallels will be concentric circles. All these formulas come directly from the formulas for Type B upon taking the limit as a approaches 90° or $\pi/2$ radians, since a plane can be considered as the limiting form of the cone as the latitude of tangency approaches 90°.

C1 $\theta = v, \qquad r = \pi/2 - u$

C2 $\theta = v, \qquad r^2 = 2(1 - \sin u) = 4 \cos^2 (\pi/4 + u/2)$

C3 $\theta = v, \qquad r = \cot (\pi/4 + u/2)$

C4 $\theta = v, \qquad r = \cot u$

Of these maps, C1 is coming more and more into use. However, it is frequently centered on other points than the North Pole. Then the meridians and parallels are no longer simple straight lines and circles, and their equations become very complicated. A number of the more recent war maps published by the National Geographic Society are of this kind. They have also published some Equiareal Maps like C2, only centered at a point on the equator. C3 is known as the Stereographic Projection and has been used to some extent. C4 is the Gnomonic, or Great Circle Projection, so called because every great circle on the earth appears on this map as a straight line, and conversely. It is used by navigators in laying out a great circle course graphically. All maps of Type C are called *Azimuthal*, because the direction of every point from the center is shown correctly.

To actually construct any one of these maps, the network of

meridians and parallels is first laid out from the formulas. For every one of the 12 kinds given here, the meridians of longitude are uniformly spaced straight lines, being parallel for Type A, and radial for Types B and C. The parallels of latitude vary in their spacing except for maps of Class 1. The actual location of each meridian and parallel is very definitely given by the formulas. In laying out these networks, the longitude v must be expressed in radian measure for all maps of Type A, while the latitude u must be in radians for all maps of Class 1. The number of meridians and parallels required for a map depends upon the amount of detail desired. After the network has been completed, points of known latitude and longitude can be located on it in exactly the same way that points are plotted on co-ordinate paper. If the points are chosen along the boundary of a continent, that boundary can be sketched in just like a graph. The latitude and longitude of any desired points can be obtained from any kind of large scale map available. The shapes and relative sizes of the various continents and islands will appear quite different on different map projections. The farther one goes on any of these maps away from the points of tangency, the greater the distortion and the scale errors become.

The intelligent student who has had trigonometry should be able to construct any of these maps. The formulas for maps A3, B2, and B3, demonstrate the use of both logarithms and trigonometric functions outside of triangle solutions. In laying out the Mercator Projection A3, the student should be warned that the log tangent tables in his Trigonometry are not natural logarithms to the base e. The formula for C2 illustrates the usefulness of Trigonometric Identities, since the second form is more conveniently solved for r. A comparison of the various kinds of maps, especially the Equiareal and Conformal maps of the same type, should prove both interesting and enlightening.

"IT AIN'T HAY," THE FARMERS SAY

A new high-protein, high-mineral, high-vitamin feed, producible by farmers on their own land, may presently replace purchased concentrates like cottonseed meal. Savings as great as $12 a ton are claimed in favor of the new feed, dried grass.

And that "ain't hay." Which is an essentially accurate statement, even if slangy. Dried grass is made from grass cut while it is young and juicy, not from grass grown mature and beginning to be a little bit tough. It is dried quickly by high-temperature artificial heat, not slowly in the sun. So it comes to the feed-rack minus only its sappiness, but with all other youthful qualities still in it. The cows love it—and thrive on it.

WHAT WE WOULD TEACH IN SCIENCE IF WE WERE TO EMPHASIZE THE NEEDS OF CHILDREN*

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Have the needs of our younger children been changed since Pearl Harbor?—Perhaps not many, but they have all been intensified and some have had different meanings added to them. The children are living in an entirely different world. At home there is stress and strain. At school things have taken on importance which heretofore didn't seem to matter much—and conversely some things which formerly seemed to count for so much, now seem very unimportant. The curriculum itself is less important that it ever was before.

To some people, the war has merely addded to the responsibility of the high school and college teacher, but to those of us working and thinking with children on the lower levels it has also brought a challenge. We are groping about for something which will mean a real boon to the younger children and parents whom we serve. It is along this line that I have been thinking and trying to sift out the ways in which elementary science could be of most service to our young children and their parents and homes. In thinking this through, I started with the report of N.E.A.'s National Committee on Science Teaching entitled "Redirecting Science Teaching in the Light of Personal-Social Needs." This study was completed and published last spring. It lists nine functional outcomes of general education toward which science teaching can contribute. I feel that this fine piece of work holds suggestions which are as important today as in pre-war days. However, I'd like to speak of the different areas which have been used in this study in the light of our living today in the crucial days of a war the like of which has never been seen on our globe.

The areas of children's needs used in this study are:

1. Responsible Socio-economic Action.
2. A Maturing Philosophy of Life.
3. Conservation
4. Intelligent Consumership.
5. Work.

* Presented at the Elementary Science Section of the Central Association of Science and Mathematics Teachers, November 27, 1942.

6. Maturing Interpersonal Relationships.
7. Recreation.
8. Safety.
9. Health.

No attempt has been made to put these in the order of their importance or significance. I feel they have almost equal importance.

Considering these outcomes or needs very rapidly in the order named, let us take Responsible Socio-economic Action first. One of the needs here, which is important now, is to build up an unselfish attitude of service to one's home, school, community and country. There are many ways the children can be taught to serve and the kind of attitude in which this service is given, is our job to build. Now is the time to build attitudes for the peace of the future, as well as the war of the present.

Strong emphasis is needed on building up an attitude of respect for another's possessions—not only material possessions but the beliefs and traditions and faiths of others. We need new emphasis on the attitude of sharing one's possessions with others. The popular phrase the "have" and the "have not" nations in speaking of the different peoples on our globe shows there is much adult thought on this subject and children should have a part in it. Science teaching has long had as its goal the teaching of scientific attitude which includes, among other points, the steps of facing the facts and being willing to change one's mind and act accordingly. This we must re-emphasize.

Next, let's take the outcome, A Maturing Philosophy of Life. There are three things which seem to me very important in this area, now that our luxurious way of life is about to crumble: one is an understanding of some of the things which make for happiness, two is a sense of values, and three is the growth in tendency and ability to do independent thinking. Science is well suited to develop these outcomes in children.

Next, let's take the area of Conservation. Here belongs the salvaging services children can perform. Dr. J. W. Studebaker, U. S. Commissioner of Education, has said,[1] "The discovery of scrap material is peculiarly a job for children." Science teaching can contribute to the different salvaging drives by helping the children to recognize metals, silk and nylon, and by helping them become intelligent about the possible uses and advantages of the different substances. Along the same line of endeavor the

[1] "A Job Children Can Do," *National Parent-Teacher Magazine*, October, 1942.

children can be taught the best methods of caring for and hence conserving these different materials.

In this area also belongs the traditional material of conservation. Now, however, it holds new stimulus. The importance of saving our soils is of major importance to world welfare now more than ever before. In time of war, food from our soils is more necessary than ever, and now with our lend-lease commitments we must help feed almost half the world, and as time goes on that fraction increases. And looking toward the future, to the time in which we will be struggling to rehabilitate the world, the food situation all over the world will be most acute, and we'll need every ounce of top soil we have. Hence the added necessity for practical knowledge of everything related to soil conservation.

Next, let us take Intelligent Consumership. In order to help children in this area of functional outcomes, we must study what children buy at each level. We must help them to judge a good article, help them to judge good school supplies, durable toys and useful gifts. We must help them to be cognizant of the fact that there is a shortage of some materials and hence of the things they might like to buy. They can be encouraged to get along with less or use a substitute. Science can contribute helpful information here.

Next, let us consider the area of Work. Children all perform some sort of work at school and at home. Science has much to offer in teaching desirable work habits. Also the child must be made to realize that he'll have to be a builder, a gardener, a chemist, etc., in the years to come. He'll have to help rebuild all the world into a more beautiful, finer world than ever before. In order to perform this service he needs science information.

Next, let us take Inter-personal Relationships. The Science Committee Report describes this functional outcome thus: "The children must be made to feel secure and certain in their relationships with other children, even though they be of different race, color or creed. They must practice and abide by democratic action." In other words we are responsible for training in tolerance. We must teach children to understand and sympathize with citizens of the world; our allies—and also our enemies. There is no reason why the works of art of the Japanese, the music and poetry and scientific works of the Germans, should be a target of hate of our children. We must let them rather be shown these things with reverence for the people of

those nations and what they were able to do *before* they became war minded or allowed themselves to be led by the war minded among them. If we are to win the peace after the war, it is necessary that we build up an understanding of the good in all people—even in our enemies. We, as teachers, can no longer be satisfied with the type of character building which has as its goal good citizens of America. It is necessary to look forward to after this war when we'll need good citizens of the world. To this end, we must start *now*. The old goal of science teaching, to overcome prejudice and superstitution, finds new impetus here.

I believe discipline belongs here also; discipline as far as our system of grades or marking is concerned. The armed forces who are absorbing our older students are asking that we put aside the idea of "Passing" and that we insist on "Mastery" of our subjects. Science is an exacting subject. I believe we have much to offer here. Our training children in scientific methods and habits will help in many ways to build maturing interpersonal relationships.

Next, let us take the area of Recreation. Science has so much to offer here that it is hard to mention some things and leave out others. I'll name just a few. (1) We can stabilize our war worried homes with children's nature interests. (2) We can apply our science facts as we correlate them with art. Science paves the way for art as it uses science information in constructing buildings, cities, etc. (3) Gardening pleasures can be greatly increased by science information. (4) We must teach children how to play and how to laugh. Many homes no longer find time or inclination for laughter and play time of any sort. Play is a child's business, and we must not overlook it. I have made up many science games which my classes greatly enjoy. Experiments themselves can be fun and as much of a challenge as any game. The desperate case of war having taken all thought of play out of children was brought home to me with a shock as I read a part of a letter from England.

"5:15 is Children's Hour—not in a dainty nursery but in a room boarded off at the entrance to a large London Tube shelter . . . These are just Tube Children, East London kids . . . There has been little leisure and scant imagination in their crowded and busy homes for play and the gracious things of life. They have to be taught, unobtrusively, how to play. . . .

"Their talk brings it home again and again that War is for them the natural state of things: it is not, as with adults and the

older children, a strange interlude. If I tell them the story of the three bears and growl, 'Who has been eating MY porridge?' an anxious little voice interrupts: 'Miss, is porridge on the ration kewpons?' . . . Even the troubles of the old woman in the shoe were solved by them in a new way. 'She had so many children she didn't know what to do' brought this excited comment: 'Why aren't they evacuated, Miss'?"[2]

Again I say, we must not forget to make some play and laughter a real objective of our science classrooms, now more than ever before.

Next, let us take the needs of children in the area of Safety. We still have our accidents due to children darting across the street, the accidents of the schoolroom, playground and home. Preventive teaching for these is more important than ever before. However, now the war has added to our traditional teaching along this line, the teaching of what to do in case of air raids. If children know all about these—are prepared for them, there should be no panic. In this case, each child will follow a teacher who is calm because her children have been prepared. This "calmness" means no panic. Panic is what the enemy is hoping for.

Children can also be taught how to make a gas-proof and bomb-proof shelter at home. If they become interested, the parents will also be, and it will then follow that our nation will be prepared. The gas raids, especially, are effective only on an unprepared and hence panic-stricken civilian population. The enemy will not use what will not be effective.

Some folks, I know, will not agree that children should be taught anything about such an unpleasant subject as these war raids. Perhaps I believe in it strongly because I am from a part of the country, the Twin Ports of Superior and Duluth, which has been designated by the War Department as one of vulnerable spots in the U.S.A., because of our harbor, shipbuilding, and the largest ore docks in the world. For this reason I have been teaching Civilian Defense classes on Gas Defense, and know how eagerly people listen to anything one can tell them concerning possible raids. I am sure parents are glad to have the children learn, and in turn teach them what to do. I was interested in reading along this line, an address given to kindergarten teachers of New York City by Margaret Mead

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[2] Portions of the letter printed in *Childhood Education*, September, 1942.

She says:

"You and I have been reared in a world which believes that it is necessary to protect children from the facts of life and death. When someone dies, when a new baby is born, when there is an accident or a severe illness or a great sorrow, the children are hurried away from it. Reared in such an atmosphere, trained to protect little children from the impact of life's piercing experiences, we are suddenly faced with the fact that it no longer lies within our power to protect them in this way. From the single death or single accident it has been possible to hurry the child away, but from the bombings and devastations of war this will not be possible. What then, can we do to keep children safe now that the old tried ways of protecting them are going to fail?

"We have the English experience to encourage us. Among the evacuated children who were sent away from their mothers and teachers to live in safe but strange surroundings, there have been many signs of nervous breakdown. Among the children who stayed with their courageous and serene parents and teachers among the falling bombs, there have been very, very few nervous breakdowns. The English experience teaches us how much more important it is *with whom* a child meets new and terrifying experiences than *what* those experiences are.

"If you can believe me when I say that children are stronger than we think, that their ability to come through unharmed is a function of *our* serenity and not the situations they face, then you as teachers need not be afraid."[3] In science we aim to give children the truth, of the disagreeable as well as the pleasant.

With this thought I'll leave the area of safety and take the last one, namely Health. Health has become of paramount importance today when the most vigorous of our doctors and nurses have left us and those who are still with us are overworked.

It means preventive medicine must be practiced more than ever before. Science teaching can do a great deal to contribute to children's part in living the rules that preventive medicine has taught us. Communicable diseases must be identified and isolated sooner than they have been before. Children must be taught the seriousness of coming to school with colds—both for their own sake and the sake of others. From the first grade

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[3] A portion of an address given to Kindergarten teachers of New York City by Margaret Mead, Associate Curator of Anthropology at the American Museum of Natural History and printed in *Childhood Education* for September, 1942.

on, we must emphasize the importance of covering a cough or sneeze.

We must teach children that to be healthy and withstand disease, they must eat the right foods. Nutrition must be emphasized more than ever before. We must get over the idea that it is a subject for older children. We can't start early enough in the life of a child to discourage "fussy eating." We must also break down the superstitition early—that nutrition is a girl's subject.

I have watched a unit on Nutrition carried out in the third grade of our Campus Elementary School, which opened my eyes to the possibility of what we can do for our children along this line. This unit was planned and carried out by Miss Minda Hovland, our third grade supervisor.

The unit was on "Food for Health." The children had discussions on what constituted a good breakfast, luncheon and dinner. They consulted their health books and the pamphlet ***Food for School Boys and Girls*** published by the Wisconsin State Board of Health. They began to wonder whether they were eating the right foods. They found milk so important as a bone builder that they decided to make charts to check the amount of milk they drank each day. Their slogan for this was "Feed your Bones." In reading, they discovered milk wasn't the only bone building food so they decided they'd like to keep track and check their own menus for other foods also. The parents who had been prepared for the unit in Parents-Teachers Meetings, cooperated throughout the unit. In some cases they wrote out the menus that the children brought to school and used in checking on their school chart. Each morning the children ran to their desks to fill in their charts. The first foods the children checked on their charts were those which helped to build bones, next those which they must chew well, and help keep their gums healthy. Toward the end of the unit they used these same charts to check whether or not they brushed their teeth each day. The children came to school with many comments such as "I got mother to have spinach and green beans for dinner because they contain bone builders." (Some of the brighter children used the word calcium.) "I am drinking more milk than I used to. I didn't use to like it very well." The children decided they'd like to build a cafeteria in their room. This is illustrated on the following page. They cut out pictures of food and put them on the counter, they fixed a bulletin board in the back of the counter with suggestions for a good breakfast under the slogan

HELEN CHOOSES A LUNCHEON

OUR CAFETERIA CASHIER

"How to Start the Day Right." Another section showed a good luncheon combination and a third section a good dinner. They also had their sheets containing the prices of the foods. They made paper money and correlated their arithmetic with this by going to the cafeteria with their paper trays made in art and picking out a breakfast, luncheon or dinner and paying for it at the cashier's desk. Many children had experience playing cashier. Toward the end of the unit the second grade was invited to come in and purchase at the cafeteria. And as a final day's work on this unit the children cooked and served real food at their cafeteria. The response of children and parents alike was most gratifying throughout the unit. And I'm thoroughly convinced that those children have been started thinking and acting on a subject which has already formed very healthy functional habits.

In closing, may I quote Paul V. McNutt[4]. He says: "The U. S. government needs education today as it never did in the history of our nation." And we, as elementary science teachers, have a great contribution to make through the redirecting of our teaching towards the solving of the problem of children's needs which are most pertinent today, in our war torn world.

[4] *Wisconsin Journal of Education*, October, 1942. "Education . . . The Shortest Distance between Two Points."

ELECTRON MICROSCOPE PROVES THEORY ACCOUNTING FOR GLEAMING COLORS OF INSECTS' WINGS

A long-held scientific theory accounting for the gleaming colors of insects' wings has been proven true by the electron microscope, science's newest powerful tool for exploring the world of the invisibly small. It has long been known that most of the iridescent colors on insects' wings are not due to pigment. On theoretical grounds, it has been supposed that they are caused by refraction of light from very fine ridges or lines, as artificial rainbow hues are cast back from the surface of glass or metal plates ruled in very fine, close lines by means of a diamond point.

Drs. Thomas F. Anderson and A. Glenn Richards, using the wing of a beetle and scales from the wing of a tropical butterfly, have now demonstrated the actual existence of the kind of lines called for by the theory. They are relatively simple on the beetle wing, but on the butterfly wing-scales they are exceedingly complex, consisting of very fine plates that stand up on edge, and are capable of sidewise movement. This movement accounts for the change of color from brilliant blue to yellow-green when alcohol is flowed on the butterfly wing.

The width of the lines of these natural refraction grids is 0.8 micron on the beetle wing, and very much finer, 0.15 micron, on the butterfly wing-scales. A micron is the microscopist's "inch"; it is a thousandth of a millimeter, or approximately a twenty-five thousandth of an inch. A fine human hair is about 25 microns in diameter.

HUMANIZING SCIENCE AND MATHEMATICS BY COMMEMORATING MARCH ANNIVERSARIES

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In previous articles (*45*, *46*, *47*)* the generalization has been expressed that, if teachers are to develop an understanding of and appreciation for the methods of the scientist, they must ***humanize*** their teaching of science and mathematics. The present paper is an attempt to implement this principle by suggesting materials and activities which are at least potentially useful for helping our young people to relive the failures and successes of some of the more important scientists and mathematicians whose birthday anniversaries we commemorate in March.

Needless to say the suggested materials and activities can be used for other purposes in addition to the commemoration of anniversaries. For example, the aids suggested for humanizing the life of Priestley should be helpful in introducing a class to the study of oxygen. Thus, suggestions for humanizing science and mathematics by commemorating March Anniversaries should be equally suggestive to the alert teacher throughout the school year.

Teachers should not expect to find all of the aids suggested available in their school library. One purpose of the bibliography is to help teachers to add to their own classroom collections each year. When a book is purchased, the plates should be carefully detached, mounted, labeled, and filed for future bulletin board use. Each classroom should develop its own file of pictures pertaining to the lives and achievements of the great scientists and mathematicians. The books without their plates will be shelved in the classroom. Flat pictures should also be filed systematically. Pupils should be encouraged to add to the class collection as opportunity permits. If facilities are available for the showing of pictures and the playing of recordings, teachers should budget a portion of their laboratory funds each year to buy or rent suitable slides, films, and recordings to aid in the humanizing of their teaching of science and mathematics.

* The first or *italic* number refers to the aids listed in the bibliography which concludes this article' and the second group of light-face figures, if any, identifies the pages. In the bibliography complete data concerning the materials and ways of securing them are given.

Scientists of the Year

In addition to the anniversaries which may be commemorated in March, 1943 may be celebrated as a centennial year in science and mathematics. Thus, it is the golden anniversary of the birth of the chemist James Bryant Conant who is now president of Harvard University. It is the centennial of the birth of Robert Koch, of the completion of the first telegraph line in the United States, and of the opening of the United States Naval Academy at Annapolis. It is the sesquicentennial of the birth of the mathematician, Nicolai Ivanovich Lobachevski. It is the bicentennial of the births of John Fitch, Thomas Jefferson, Martin Klaproth, and Antoine Laurent Lavoisier. It is the bicentennial of the founding of the American Philosophical Society. It is the quadrennium of the publication of Copernicus' *De Revolutionibus Orbium Celestium*. It is the sesquiquadrennium of the birth of Paracelsus.

Telephones and Vitamins

On March 3, 1847 Alexander Graham Bell was born in Edinburgh, Scotland and on the same day, thirty-two years later Elmer Verner McCollum first saw the light of day in Fort Scott, Kansas. However, these two scientists have more than their birthdays in common. They are partners, this inventor and this biochemist, seeking to discover some fundamental relations in the seeming complexity of nature. Their brilliant researches can well be studied by any who would understand and appreciate the methods of science.

McCollum's work in the study of vitamins is an excellent example of scientific method. The story is well told by Jaffe (*21:* 240–280). A portrait (*21:* 250) is included and could be made the center of a stimulating bulletin board display on the vitamins.

An imposing array of materials is easily accessible for a study of the methods of Alexander Graham Bell. Students can dramatize the story of the discovery of the telephone from the materials contained in the biography of Bell by MacKenzie (*25:* 86–101). This book also contains twenty-two full page plates which can be detached without injury to the book for a bulletin board display on the life of this great inventor. A portrait of Bell and Watson is included in Towers (*35:* 160) as is also a very elementary account (*35:* 140–187) of Bell's development of the telephone. The story of the birth of the telephone is told in

simple prose by Darrow (*8:* 281–293). A re-creation of the events in telephone progress leading to coast-to-coast communication has been filmed (*59*). A recording (*58*) showing the relations of Bell's discovery to easy communication and the American way of life is available. Students interested in aeronautics could explore with profit MacKenzie's account (*25:* 287–341) of Bell's experiments on flight.

The Sailors' Friends

If Bell is "the man who contracted space," it is Gerardus Mercator who gave us a method for mapping space on the earth's surface. It was in 1568 that he "published his memorable planisphere for use in navigation, the first map on 'Mercator's projection,' with the parallels and meridians at right angles." An excellent bulletin board display to commemorate the anniversary of the birth of this Flemish mathematician and geographer on March fifth would be a graphical representation of the advantages and disadvantages of "Mercator's projection." More advanced students could document the ways in which Mercator "helped to free geography from the tyranny of Ptolemy"(*12*).

Two hundred thirty-four years after Mercator published his planisphere for use in navigation, Nathaniel Bowditch wrote *The New American Practical Navigator.* If a copy is accessible it would be appropriate to display it as "the Seaman's Bible" on the anniversary of his birth, March twenty-sixth. Portraits of Bowditch will be found in Berry (*4*) together with the story of the life of this *Yankee Stargazer.*

Pioneers in Spectroscopy

The Yankee Stargazer, Bowditch, was fourteen years old when Joseph von Fraunhofer was born, thirty-eight years of age when Robert Wilhelm von Bunsen arrived on the scene, and had lived fifty-one years before Gustav Robert Kirchhoff made his entrance in the drama of life. And it is with the trio whom we have just introduced that stargazing begins to concern itself with the determination of the chemical composition of the stars. Since the birthday of each member of this triumvirate is in March,† a bulletin board exhibit to commemorate their contributions to the science of spectroscopy seems appropriate. Il-

† Although the *Britannica* (*12*) gives the date of Bunsen's birth as March 31, Weeks (*37:* 183) says that this is uncertain.

lustrations from which sketches can be prepared will be found in Weeks (*37:* 182–192). A colored reproduction of a painting of Fraunhofer (*49*) is available. A portrait of Bunsen will be found in Lenard (*23:* 317). Materials for a report on the contributions of the three men to spectroscopy are contained in Darrow (*8:* 206–213) and Lenard (*23:* 198–204, 324–338). A steel engraving of Bunsen (*54*) for framing is available. Students could get permission to name their chemistry laboratory the "Bunsen Laboratory of Chemistry" and present this picture framed to the school for hanging in the laboratory.

As an example of cooperative activity in scientific investigation, teachers would do well to call the attention of their students to the friendship between Bunsen and Kirchhoff. As Lenard (*23:* 324) reminds us: "Bunsen and Kirchhoff, from the days when spectrum analysis was a great and new conquest of the human mind, and old Heidelberg was the place sung by poets and singers, are a combination, which in spite of all that has passed since their time, is still unforgotten, and will always remain so. Two rare men of science came together at the most fruitful time of their lives; they joined forces in the most fortunate manner for the purpose of investigating an entirely new road to the discovery of facts."

Watchers of the Sky

Not only Yankee stargazers, but also English and French stargazers were extending man's conception of space during the eighteenth and nineteenth centuries. Three of these have March as a common birthmonth. Two of the three are members of one of the most illustrious families in astronomy, Carolina Herschel and Sir John Herschel. Their story is well told by Ball (*2:* 247–271). A poet's conception of the work of Sir John Herschel is given in Noyes (*29:* 244–271).

Lalande has said of the third member of our trio, Nicholas Louis de Lacaille, that during a comparatively short life, he had made more observations and calculations than all the astronomers of his time put together (*12*). Perhaps a copy of his star catalogue will be available for exhibition on the anniversary of his birth, March fifteenth.

The Plant Wizards

March seventh is the birthday anniversary not only of Sir John Herschel, a star wizard, but also of two plant wizards,

Luther Burbank and Mark Alfred Carleton. A bulletin board display showing some of the creations of Burbank would be a fitting commemoration of the anniversary of his birth. Ample plates may be obtained from Hall's transcription of Burbank's eight volume work entitled *How Plants Are Trained to Work For Man* (7). The chapter entitled "Planning a New Plant" (*7:* 85–96) is a good description of scientific method as applied to the problem of getting an early cherry. A short biography (*7:* 1–12) introduces the book. A part of the life of this skillful experimenter is depicted in a film (*65*). Recordings on *Gardening the Luther Burbank Way* (*57*) are also available.

In commemoration of the anniversary of the birth of Carleton, students could easily dramatize the chapter entitled "The Wheat Dreamer" in Paul de Kruif's *Hunger Fighters* (*9:* 3–30). The film *Forgotten Victory* (*63*) depicts his attempts to introduce hard wheat into America.

The Romance of Chemistry

During the nineteenth century men found romance not only in working with plants but also in experimenting with such commonplace things as sand and coal. Three of the more noteworthy of these chemical romancers whose birthday anniversaries we commemorate in March are Edward Goodrich Achelson, Sir William Henry Perkin, and James Bryant Conant.

The famous experiment which led Achelson to the discovery of carborundum is depicted in the film *Manufactured Abrasives* (*66a* and *66b*). The story of this discovery is also available in two pamphlets (*39* and *41*).

Perkin's discovery of the first coal tar dye when he was only eighteen years of age is told by Darrow (*8:* 228–237).

The last of our trio of chemical romancers will celebrate the golden anniversary of his birth on March 26, 1943. He is recognized as one of the more brilliant organic chemists of our country. His researches into the chemical structure of chlorophyll are noteworthy. He is the co-author of a famous textbook in high school chemistry. As president of the oldest university in America, his name is often in the headlines. A scrapbook of clippings dealing with the work of this well-known educator and scientist would be a fitting commemoration of his golden birthday anniversary.

Frogs and Ants

On the same day that Alexander Graham Bell spoke the first

sentence ever received by the electric telephone but two hundred forty-eight years before, in the same year that William Harvey published *Exercitatio de Cordis Motu*, Marcello Malpighi was born near Bologna, Italy. Sir Michael Foster, the English physiologist whose birthday is also in March, in lecturing on the history of physiology compared Harvey and Malpighi as follows: "Harvey shewed that blood did sweep through the tissues; Malpighi shewed what the tissues were and how the blood swept through them." Materials for a report on Malpighi's methods of study are contained in Foster (*13:* 84–120), Locy (*24:* 229–240) and Fulton (*14:* 61–67). A portrait of Malpighi is found in Fulton (*14:* 62) as are quotations from the *De Pulmonibus* of Malpighi in which he reports the results of his studies on the lungs of frogs.

An American zoologist, William Morton Wheeler, and Malpighi share March as their birthmonth. It was Wheeler who studied colony founding among ants and social life in general among the insects. A display of his interesting books on these subjects would be appropriate in commemoration of the anniversary of his birth, March nineteenth.

Playfair's Axiom

On the same day of the month that Malpighi was born but one hundred twenty years later the Scottish mathematician, John Playfair, was born. While Malpighi studied those elements of the circulatory system known as capillaries, Playfair concerned himself with the elements of geometry. It was he who ennunciated the axiom now known by his name which states that two intersecting straight lines cannot both be parallel to the same straight line. A bulletin board display illustrating this axiom would be appropriate to commemorate the anniversary of his birth.

Neptune and Mars

March twelfth is the birthday anniversary of four great scientists. Two of the chemists, Kirchhoff and Perkin, we have already introduced. The chemist and physicist, Daniell, we shall introduce later. The astronomer, Simon Newcomb, will serve to introduce a trio of astronomers who contributed to our knowledge of the planets.

Newcomb is one of the most beloved of American astronomers. A display of his popular books on astronomy would be not only a fitting commemoration of his birth but also a means of

arousing interest in astronomy. The frontispiece of his own *Reminiscences* (*28*) or a larger portrait (*50* and *53*) could serve as a center for the display. A plate showing a memorial to him (*48*) is also available.

The birthday anniversary of the second member of our trio of astronomers is celebrated on the day before that of Newcomb, while the anniversary of the third member is commemorated on the day following Newcomb's anniversary. Both are popularly identified with planetary studies, Urbain Jean Joseph Leverrier with Neptune and Percival Lowell with Mars.

It was Leverrier who revealed the existence of Neptune by mathematical calculation although he never made a telescopic discovery. The story of Leverrier furnishes an excellent example of scientific reasoning and of the part that mathematics plays in scientific method. The story is well told by Ball (*2:* 335–353).

Lowell founded an observatory at Flagstaff, Arizona for the special purpose of studying planets. He is popularly known as a protagonist of the theory of an artificially constructed network of canals on Mars. A summary of Lowell's theory and another astronomer's objections to it will be found in Jones (*22:* 211–227). A reading of this popular account will serve to show the checks and balances on the use of imagination in scientific investigation.

Discoverers of Elements

We have already introduced a pair of chemists who discovered a pair of elements. It was Bunsen and Kirchhoff who discovered cesium and rubidium. We shall now introduce three other chemists who also discovered chemical elements: Joseph Priestley who discovered oxygen, Carl Löwig who prepared bromine before Balard had announced its discovery, and Eugène Melchoir Péligot who was the first to isolate uranium.

Priestley was born on the same day of the month as Percival Lowell but one hundred twenty-two years earlier. He has been called "the father of pneumatic chemistry" for his preparation not only of oxygen, but also of carbon monoxide, nitric oxide, nitrous oxide, hydrogen chloride, and ammonia. The story of his preparation and study of "dephlogisticated air" illustrates the role of chance in discovery and is a striking example of the influence of a dominant theory on the thinking of a scientist. This story can serve to warn us against allowing theories to become our masters rather than our servants. The story may be

found in Darrow (*8:* 30–33), Jaffe (*20:* 51–72), Holt (*17:* 95–109), Stillman (*33:* 479–498), and Weeks (*37:* 37–44). The illustrations in the latter book could be copied by talented pupils for a bulletin board display. The sketch in the *Cenco News Chats* (*44*), the portrait in the Perry Pictures (*51*), the frontispiece in Holt (*17*), and the portrait in Jaffe (*20:* 55) should prove helpful in this display. Student reports could be based upon Huxley's estimate of Priestley (*18a:* 1–37) or upon Smith's evaluation (32) of Priestley's contributions to chemical research in the young American Republic. For those students who are interested in reading from the writings of the great scientists selections from Priestley's *Experiments and Observations upon Different Kinds of Air* are available in Fulton (*14:* 119–122). Biology students will be interested in reading Foster's estimate of Priestley's contributions to physiology (*13:* 237–244). Chemistry students will enjoy the film (*64*) showing Priestley's discovery of oxygen.

Löwig was born March 17, 1803. His preparation of bromine in 1825 before Balard had announced its discovery is an excellent illustration of those independent simultaneous discoveries with which the history of science abounds. The story of Löwig's discovery is told by Weeks (*37:* 262–264).

Péligot was born in the same year as Bunsen and Leverrier. The story of his isolation of uranium is available in Weeks (*37:* 56–60). Portraits of both Löwig and Péligot are given in Weeks. These could serve as models for sketches by talented students.

Two Microbe Hunters

Although Paul Ehrlich did not discover a chemical element he did prepare 606 chemical preparations before he discovered that dioxy-diamino-arsenobenzol-dihydro-chloride would help to fight the syphilis spirochete. The story of Ehrlich's method of trial and sweating should serve as an inspiration if not a model for future microbe hunters, especially those who today because of their race would be outcasts from Germany. Ehrlich's namesake, Paul de Kruif, tells the story in his dramatic style (*10:* 334–358), and in the *Reader's Digest* (*42*) describes how artificially induced fever has turned Ehrlich's arsenic compound into *The Magic Bullet*. For those who can see the motion picture film of the same title, Edward G. Robinson's superb characterization will make Ehrlich's story live for a long time. A bulletin board display on "Doktor Phantasus," as Ehrlich was sometimes cartooned in Germany, could be prepared using the por-

traits in de Kruif (*10:* 354) and Bigger (*5:* 220) as a nucleus.

In the same month of the same year that Ehrlich was born but seven days later, another microbe hunter Giovanni Battista Grassi was born. The story of his experiments in tracking down the cause of malaria is told by de Kruif (*10:* 278–311). This story, presented as a radio dramatization, will help pupils to a better understanding of the meaning of scientific method.

Two Electrical Pioneers

We have already called attention to March twelfth as the birthday anniversary of four great scientists: Kirchhoff, Perkin, Newcomb, and Daniell. The first three have been introduced; the fourth introduces a pair of pioneers in electrical research.

John Frederic Daniell was the first professor of chemistry at the newly founded King's College, London. He is best known as the inventor of the Daniell cell and of Daniell's dew-point hygrometer. An exhibit centered around either of these would be a fitting commemoration of the anniversary of his birth.

The second of our pair of electrical pioneers, George Simon Ohm, was born in the same month of the same year as Fraunhofer and on the same day of the month as Carolina Herschel. His famous law which carries his name is known by all who possess even an elementary knowledge of electricity. The story of the shameful treatment of Ohm immediately following the publication of his law should serve as an inspiration to those who are striving to think scientifically. The story is told by Hart (*16:* 233–247) and Lenard (*23:* 236–240). A portrait suitable for bulletin board purposes (*23:* 240) is included in the latter book.

New Conceptions of Heat

Three great scientists share March twenty-sixth as their birthday anniversary. All three are sons of Massachusetts. The Yankee stargazer Bowditch and the Yankee chemist Conant we have already introduced. We shall let the third Yankee, Benjamin Thompson, introduce a pair of scientists who gave us new conceptions of heat.

Benjamin Thompson is usually referred to as Count Rumford. He is a Yankee only by birth having achieved success in Europe, as his title indicates. His own cosmospolitanism illustrates a basic characteristic of science. His versatility is well portrayed in the informal biography by James Alden Thompson (*34*). A report showing how his experiments contributed to the over-

throw of the caloric theory of heat and to the acceptance of the molecular theory of heat can be prepared from Lenard (*23:* 170–175) and Trattner (*36:* 121–143). Ten plates suitable for a bulletin board display will be found in Thompson (*34*). Portraits are also contained in Lenard (*23:* 176) and Trattner (*36:* 134).

If Rumford's experiments turned man's attention to a new conception of heat, those of Rudolf Diesel gave us one of the most important applications of the new views, the engine now called by his name. The tragic story of the inventor of the Diesel engine is well told in an article by Henry Crew which is reprinted in the *Science Yearbook* (*30:* 193–201). A short summary of the story together with an exceedingly lucid explanation of the principle of the modern Diesel engine may be had in pamphlet form (*40*). The same story is also available as a film (*60*). The development of the Diesel engine in relation to aeronautics is traced in Black (*6:* 238–241).

Two Electron Detectives

On the same day of the month as Grassi but nine years before, Wilhelm Konrad von Röntgen was born. The experiments of this Italian microbe hunter and this German electron detective serve to illustrate the basic characteristics of scientific method. The full details concerning Röntgen's discovery are given in Glasser (*15:* 1–51). Students would profit from a dramatization of this story. Margaret Boveri's personal reminiscences of Röntgen are contained in the same book (*15:* 52–198). The book also contains many illustrations which can be copied for a bulletin board display. The frontispiece can be detached for this purpose. A film slide (*55*) and a film (*62*) showing how X-rays were discovered in Röntgen's quiet university laboratory and how they were subsequently utilized are also available.

In the same month but twenty-three years after the birth of Röntgen, an American electron detective, Robert Andrews Millikan, was born. He has made significant additions to our knowledge of electronic phenomena. The story of his contributions and his portrait will be found in Jaffe (*21:* 317–368).

The Father of English Geology

William Smith was born on March 23, 1769. He was the first to recognize the real significance of fossils as a means of determining the age of the strata in which they occur. His contribu-

tions to the development of geology as a science and his portrait are contained in Adams (*1:* 268–276).

Architects of the Universe

We have previously noted that Leverrier was able to determine the position of Neptune before the telescopic discovery of the planet. However, these calculations for Neptune with which Leverrier's name is popularly identified were only incidental to a larger problem with which he was concerned. His aim was the elaboration of the scheme of the heavens traced out by his fellow countryman, Pierre Simon Laplace, in *Mécanique Céleste*, the work which the Yankee stargazer Bowditch translated into English. In this work Laplace systematized the thinking of three generations of illustrious mathematicians on gravitation. With the publication of this work in the first quarter of the nineteenth century the Newtonian Revolution properly comes to a close only to be followed a century later by the Einsteinian Revolution. Since the birthday anniversaries of both Laplace and Einstein are in March, it is doubly appropriate to commemorate in this month the work of these two architects of the universe.

The French mathematical genius was born just one hundred years before the American plant wizard, Luther Burbank. The materials for a report on his life are contained in Ball (*2:* 219–232), (Bell *3:* 172–182), and Lenard (*23:* 218–223). Ball and Lenard stress his work as an astronomer while Bell stresses his mathematical contributions. Portraits of Laplace for bulletin board use will be found in Bell (*3:* 178) and Lenard (*23:* 213). A portrait (*52b*) for framing is also available. Those students who read French will enjoy the summary of astronomical history with which Laplace ends his ***Exposition du système du Monde.*** It is regarded by some as one of the masterpieces of the French language.

The German mathematical wizard was born in the same year as the American vitamin pioneer, McCollum. He was born on the same day of the month as the microbe hunter, Ehrlich. Because he cannot meet Hitler's qualifications for membership in the master race, he is now in exile from Germany. A report of his life can be prepared by consulting Moszkowski (*27:* 220–243), Reichinstein (*31:* 187–235), Trattner (*36:* 375–403), and Wilson (*38:* 367–389). Einstein's own views on the meaning of scientific method are reported in Moszkowski (*27:* 88–114). Portraits for a bulletin board display will be found in Reichinstein

(*31:* 237) and Trattner (*36:* 390). A recording (*56*) on which Einstein tells why he is glad to be an American is available. A film (*61*) which explains the elements of Einstein's theories by means of animated diagrams as well as by ordinary cinematography may be secured. A poet's impression of Einstein is given by MacLeish (*26:* 67–75).

Another mathematical physicist whose method is like Einstein's shares March with Einstein as his birthmonth. He is Richard Chace Tolman. Materials for a report on his method and a portrait will be found in Jaffe (*21:* 506–516).

A Debunker of Racial Myths

Neither Ehrlich nor Einstein are regarded by Hitler as members of the master race. However, Aleš Hrdlička, who was born in the same month as William Smith and just a century later, debunks such notions. To him the purity of the Aryan "race" and the supremacy of the Nordics are just infantile myths. For a report on his work and opinions in anthropology and his portrait, consult Jaffe (*21:* 47–80).

The Founder of Analytic Geometry

On the same day of the month that Bunsen was born but two hundred fifteen years before René Descartes was born. A report on his contributions to mathematics can be prepared by consulting Bell (*3:* 35–55) and Hart (*16:* 125–137). Portraits for a bulletin board display can be obtained from Bell (*3:* 50) and Keyser (*43*). Students might frame a portrait (*52a*) and hang it in a classroom to be named in honor of the man who made modern geometry possible, "The Descartes Laboratory of Mathematics." Biology students might be interested in Foster's estimate of Descartes as a physiologist (*13:* 57–62). Students of French could increase their understanding of scientific method by reading *Discours de la méthode*. All students would do well to read Huxley's famous essay on this work (*18b*).

The above are only a few of the many anniversaries which may be commemorated in March. Moreover the activities suggested for any anniversary can be extended and supplemented in many ways. No one teacher would want to commemorate all of the anniversaries or to utilize all of the activities listed for a particular anniversary; but it is the author's hope that every science and mathematics teacher will select at least one March anniversary and commemorate it in an appropriate manner. To

facilitate the planning of these projects, this paper is concluded with a calendar of the birthdays mentioned, a chronology of the birthyears to which reference has been made, and a classified bibliography of the instructional aids utilized in the activities.

Calendar of March Birthdays

3 Bell	12 Daniell	19 Wheeler
3 McCollum	12 Kirchhoff	22 Millikan
4 Tolman	12 Newcomb	23 Smith
5 Mercator	12 Perkin	24 Péligot
6 Fraunhofer	13 Priestley	26 Rumford
7 J. Herschel	13 Lowell	26 Bowditch
7 Burbank	14 Ehrlich	26 Conant
7 Carleton	14 Einstein	27 Röntgen
8 Foster	15 Lacaille	27 Grassi
9 Achelson	16 C. Herschel	28 Laplace
10 Malpighi	16 Ohm	29 Hrdlička
10 Playfair	17 Löwig	31 Descartes
11 Leverrier	18 Diesel	31 Bunsen

Chronology of Birthyears

1512 Mercator	1790 Daniell	1854 Grassi
1596 Descartes	1792 J. Herschel	1854 Ehrlich
1628 Malpighi	1803 Löwig	1855 Lowell
1713 Lacaille	1811 Péligot	1856 Achelson
1733 Priestley	1811 Leverrier	1858 Diesel
1748 Playfair	1811 Bunsen	1865 Wheeler
1749 Laplace	1824 Kirchhoff	1866 Carleton
1750 C. Herschel	1835 Newcomb	1868 Millikan
1753 Rumford	1836 Foster	1869 Hrdlička
1769 Smith	1838 Perkin	1879 Einstein
1773 Bowditch	1845 Röntgen	1879 McCollum
1787 Fraunhofer	1847 Bell	1881 Tolman
1787 Ohm	1849 Burbank	1893 Conant

Audio-Visual Aids for Humanizing Science and Mathematics

I. Books Containing Aids

1. Adams, Frank Dawson, *The Birth and Development of the Geological Sciences*. Baltimore, The Williams and Wilkins Company, 1938. vi+506 pp.

2. Ball, Sir Robert S., *Great Astronomers*. London, Sir Isaac Pitman and Sons, Ltd., 1906.
3. Bell, Eric Temple, *Men of Mathematics*. New York, Simon and Schuster, 1937. xxi+592 pp.
4. Berry, Robert Elton, *Yankee Stargazer: The Life of Nathaniel Bowditch*. New York, Whittlesley House, 1941. xii+234 pp.
5. Bigger, Joseph W., *Man Against Microbe*. New York, The Macmillan Company, 1939.
6. Black, Archibald, *The Story of Flying*. New York, Whittlessey House, 1940. xvi+267 pp.
7. Burbank, Luther, *Partner of Nature*. New York, D. Appleton-Century Company, 1939. x+315 pp.
8. Darrow, Floyd L., *Masters of Science and Invention*. New York, Harcourt, Brace and Company, 1923. vi+352 pp.
9. de Kruif, Paul, *Hunger Fighters*. New York, Harcourt, Brace and Company, 1928. 377 pp.
10. de Kruif, Paul, *Microbe Hunters*. New York, Harcourt, Brace and Company, 1926. viii+363 pp.
11. *The Encyclopedia Americana*, New York, Americana Corporation, 1939 edition.
12. *The Encyclopaedia Britannica* (Fourteenth Edition). London, The Encyclopaedia Britannica Company, Ltd., 1937.
13. Foster, Sir M., *Lectures on the History of Physiology during the Sixteenth, Seventeenth and Eighteenth Centuries*. Cambridge, University Press, 1901. viii+310 pp.
14. Fulton, John Farquhar, *Selected Readings in the History of Physiology*. Springfield, Illinois, Charles C Thomas, Publisher, 1930. xx+317 pp.
15. Glasser, Otto (Tr.), *Wilhelm Conrad Röntgen*. Springfield, Illinois, Charles C Thomas, 1934. xii+494 pp.
16. Hart, Ivor B., *Makers of Science*. London, Oxford University Press, 1923. 320 pp.
17. Holt, Anne, *A Life of Joseph Priestley*. London, Oxford University Press, 1931. xviii+221 pp.
18a. Huxley, Thomas Henry, *Collected Essays*—Volume III (*Science and Education*). New York, D. Appleton and Company, 1897.
18b. Huxley, Thomas Henry, *Collected Essays*—Volume I (*Method and Results*). New York, D. Appleton and Company, 1897.
19. Hylander, C. J., *American Inventors*. New York, The Macmillan Company, 1934. xvi+216 pp.
20. Jaffe, Bernard, *Crucibles*. New York, Newton Publishing Company, 1930. viii+378 pp.
21. Jaffe, Bernard, *Outposts of Science*. New York, Simon and Schuster, Inc., 1935. xxvi+547 pp.
22. Jones, H. Spencer, *Life on Other Worlds*. New York, The Macmillan Company, 1940.
23. Lenard, Philipp (Hatfield, H. Stafford, Tr.), *Great Men of Science*. New York, The Macmillan Company, 1933. xxii+389 pp.
24. Locy, William A., *The Story of Biology*. Garden City, New York, Garden City Publishing Company, Inc., 1925. xiv+495 pp.
25. MacKenzie, Catherine, *Alexander Graham Bell*. Boston, Houghton Mifflin Company, 1928. xiv+382 pp.
26. MacLeish, Archibald, *Poems, 1924–1933*. Boston, Houghton, Mifflin Company, 1933. vi+304 pp.
27. Moszkowski, Alexander (Brose, Henry L., Tr.), *Einstein, The Searcher*. New York, E. P. Dutton and Company, 1921.

28. Newcomb, Simon, *The Reminiscences of an Astronomer*. Boston, Houghton, Mifflin and Company, 1903. xii+424 pp.
29. Noyes, Alfred, *Watchers of the Sky*. New York, Frederick A. Stokes Company, 1922.
30. Ratcliff, John D. (ed.), *Science Yearbook of 1942*. New York, Doubleday, Doran and Company, Inc., 1942. xxviii+279 pp.
31. Reichinstein, David (Juers, M. and Sigmund, D., Tr.), *Albert Einstein*. Prague, Stella Publishing House, Ltd., 1934. 255 pp.
32. Smith, Edgar F., *Priestley in America*. Philadelphia, P. Blakiston's Son and Company, 1920, 173 pp.
33. Stillman, John Maxson, *The Story of Early Chemistry*. New York, D. Appleton and Company, 1924. xiv+566 pp.
34. Thompson, James Alden, *Count Rumford of Massachusetts*. New York, Farrar and Rinehart, 1935. xvi+275 pp.
35. Towers, Walter Kellogg, *From Beacon Fire to Radio*. New York, Harper and Brothers, 1924. 303 pp.
36. Trattner, Ernest R., *Architects of Ideas*. New York, Carrick and Evans, Inc., 1938. 426 pp.
37. Weeks, Mary Elvira, *The Discovery of the Elements*. Easton, Pennsylvania, Mack Printing Company, 1935. iii+371 pp.
38. Wilson, Grove, *The Human Side of Science*. New York, Cosmopolitan Book Corporation, 1929. xi+397 pp.

II. Pamphlets Containing Aids

39. *The Romance of Carborundum*, Niagara Falls, New York, The Carborundum Company, 1941. 24 pp. Free to teachers.
40. *Diesel, The Modern Power*, General Motors Corporation, Research Laboratories Division, Technical Data Department, 1938. 31 pp. Free to teachers.
41. Tone, Frank J., *Abrasives in the Service of Industry*. Niagara Falls, New York, The Carborundum Company, 1942. 24 pp. Free to teachers.

III. Recent Periodicals Containing Aids

42. de Kruif, Paul, "Found: A One-Day Cure for Syphilis," *Reader's Digest*, Vol. 41, No. 245, pp. 10–14, Stptember, 1942.
43. Keyser, Cassius Jackson, "Symposium on the Life and Work of René Descartes," *The Scientific Monthly*, Vol. XLIV, pp. 477–480, May, 1937. (Reprint available from Pictorial Mathematics, 186th Street and Amsterdam Avenue, New York City, New York for a 2 cent stamp.)
44. Sketch of Joseph Priestley, *Cenco News Chats*, No. 34, October, 1941. Central Scientific Company, Chicago, Illinois. Free to teachers.
45. Teller, James D., "A Calendar of the Birthdays of Scientists," School Science and Mathematics, Vol. 41, pp. 614–615, 768, 884–885. Vol. 42, pp. 87–88, 187–188, 207–208, 312–314, 490–492, 574–576, October 1941–June 1942.
46. Teller, James D., "Humanizing the Teaching of Science by Using the Bulletin Board," School Science and Mathematics, Vol. 41, pp. 611–619, October, 1941.
47. Teller, James D., "Humanizing Science and Mathematics by Commemorating November Anniversaries," School Science and Mathematics, Vol. 42, pp. 737–752, November, 1942.

IV. Flat Pictures

48. Memorial to Simon Newcomb. Available from Pictorial Mathematics,

186th Street and Amsterdam Avenue, New York City, New York. Price of plate is 10 cents.

49. Painting of Joseph Fraunhofer. (*Milestones in Optical History* Series.) $7\frac{1}{2} \times 8\frac{1}{2}$ inches. Available from Bausch and Lomb Optical Company, Rochester, New York.
(A brochure of 12 paintings is given free to each school. Frames for the pictures sell for $4.00 cash with order.)
50. Photogravure of Simon Newcomb. (*Scientific Worthies* series.) Available from The Macmillan Company, New York City, New York. Price $2.50.
51. Portrait of Joseph Priestley. (Teller set of 30 Science Teachers' Collection of Pictures.) $5\frac{1}{2} \times 8$ inches. Available from The Perry Pictures Company, Malden, Massachusetts. Send 60 cents in stamps or money order for the complete set of 30 pictures. Single pictures are not available.
52a. Portrait of René Descartes. 10×14 inches. Available from Pictorial Mathematics, 186th Street and Amsterdam Avenue, New York City, New York. Price 50 cents.
52b. Portrait of Laplace. 10×14 inches. Available from Pictorial Mathematics, 186th Street and Amsterdam Avenue, New York City, New York. Price 50 cents.
53. Portrait of Simon Newcomb. $6\frac{1}{2} \times 9\frac{1}{2}$ inches. Available from Pictorial Mathematics, 186th Street and Amsterdam Avenue, New York City, New York. Price 10 cents.
54. Steel engraving of Robert Wilhelm Bunsen. (*Scientific Worthies* series.) Available from The Macmillan Company, New York City, New York. Price $2.50.

V. Film Strip

55. *X-rays.* 35 mm. Available from General Electric Company, Visual Instruction Section, Publicity Department, Schenectady, New York. Address request for permanent loan of this filmslide to the General Electric Office in your territory.

VI. Recordings

56. Address by Albert Einstein. (*I'm An American* series.) One 16-inch record, one side, 15-minute program at $33\frac{1}{3}$ r.p.m. Available from Educational Radio Script and Transcription Exchange, Federal Radio Education Committee, U. S. Office of Education, Federal Security Agency, Washington, D. C. Loaned free.
57. *Gardening the Luther Burbank Way.* Seven 16-inch records, each containing two 15-minute programs at $33\frac{1}{3}$ r.p.m. Available from Radio Transcription Company of America, Hollywood Boulevard at Cosmo, Hollywood, California.
58. Speech on Wings. (*Lest We Forget,* Series II.) One 16-inch record, one side, 15-minute program at $33\frac{1}{3}$ r.p.m. Available from the Institute of Oral and Visual Education, Radio Division, New York City, New York. Loaned to schools free of charge.

VII. Motion Pictures Films

59. *A Continent is Bridged.* One 16 mm. sound reel in black and white, 40-minute program. Available from Ohio Bell Telephone Company, 750 Huron Road, Cleveland, Ohio. Free loan. Inquire at the nearest business office of the company.
60. *Diesel, The Modern Power.* One 16 mm. sound reel in black and white, 23-minute program. Available from General Motors Corporation,

Department of Public Relations, 1775 Broadway, New York City, New York. Free loan.

61. *Einstein's Theory of Relativity.* One 16 mm., silent reel in black and white. 30-minute program. Available from Eastman Kodak Stores, Inc., 356 Madison Avenue, New York City, New York. Rental is $2. Consult your local distributor also.
62. *Exploring with X-rays.* Four 16 mm., sound reels in black and white, 40-minute program. Available from General Electric Company, Visual Instruction Section, Publicity Department, Schenectady, New York. Free loan. Address your request to the General Electric Office in your territory.
63. *Forgotten Victory.* (MGM *Passing Parade* series.) One 16 mm., sound reel in black and white, 11-minute program. Available from Teaching Film Custodians, 25 West 43rd Street, New York City, New York. Loaned on payment of $5 fee. Consult your local distributor also.
64. *Historical Introduction to the Study of Chemistry.* One 16 mm., silent reel in black and white, 15-minute program. Available from Eastman Kodak Company, Teaching Films Division, Rochester, New York. Sales price is $24. Consult your local distributor for rental possibilities.
65. *Luther Burbank.* One 16 mm., silent reel in black and white, 12-minute program. Available from Eastman Kodak Company, Teaching Films Division, Rochester, New York. Sales price is $18. Consult your local distributor for rental possibilities.

66a. *Manufactured Abrasives.* Two 16 mm., silent reels in black and white, 30-minute program. Available from Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh, Pa., or a subdistributing center of the Bureau. Free loan.

66b. *Manufactured Abrasives.* Two 16 mm., sound reels in black and white, 24-minute program. Available from Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh, Pa., or a subdistributing center of the Bureau. Free loan.

LIFE ON EARTH DEPENDS ON OZONE

That anyone on this earth is alive today is due to a small amount of ozone scattered in the atmosphere high above our heads, according to Dr. E. W. Gudger, ichthyologist of the American Museum of Natural History, writing in *The Scientific Monthly.*

This ozone, which is simply oxygen with three instead of two atoms to the molecule, cuts off the ultraviolet rays from the sun just about at the point where they become deadly to bacteria. A little less ozone, and life on this planet could not even have got started. A little more ozone, and we would be deprived of the healthful ultraviolet which produces suntan and our sunshine vitamin D.

Yet the amount of ozone that performs this vital service is exceedingly small. The ozone layer extends from a height of about 9 miles to 22 miles. But if the ozone molecules scattered in this 13 mile thick layer were collected all by themselves at the bottom of the atmosphere, they would form a layer there only one-eighth inch thick. So thin a screen spells the difference for us between life and death.

SYNTHETIC RUBBER*

CHARLES C. PRICE
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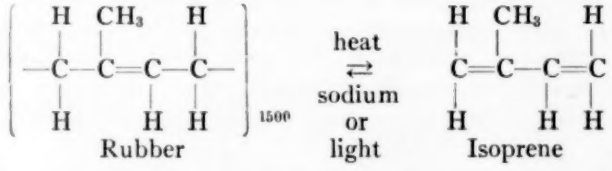
Since Japan has deprived us of our major source of rubber, the synthesis of compounds to replace this strategic raw material has been a vital part of our war program. Plants now in operation, under construction or in blue-prints will give us synthetic rubber at the rate of a million tons a year by 1944. This is more than double our yearly rubber imports during the 1930's and will represent a thousand-fold increase in synthetic rubber production over a period of only five years.

Chemically, rubber is built up entirely of carbon and hydrogen atoms in the ratio of five to eight. Estimations of the molecular weight of rubber have shown it to be enormously large; each molecule may contain as many as 7500 carbon atoms and 12,000 hydrogen atoms. An indication of the structural arrangement of this "giant" molecule was derived from its decomposition by heat to the relatively simple substance, isoprene, which had the same composition as rubber itself. Still more significant was the observation that many isoprene molecules can react with each other to regenerate material closely resembling rubber. It is thus evident that isoprene and rubber bear much the same relationship as a chain to its individual links. Rubber is said to be a *polymer* of isoprene and the process of uniting the many small molecules to one large one is called *polymerization*.



Rubber Isoprene

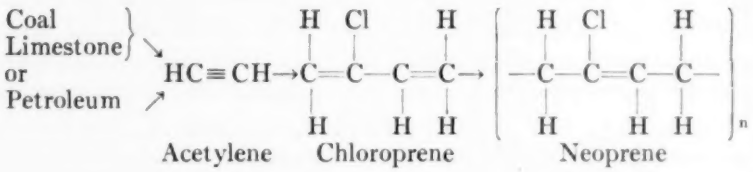
Small amounts of true synthetic rubber are made by this process. The isoprene is obtained by heat decomposition of turpentine. The value of this material in comparison with other synthetic rubbers is its retention of elasticity at extremely low temperatures, a very useful property for airplane de-icers.

Large scale commercial application of rubber was made possible by the discovery of vulcanization. On heating rubber with

* Presented at the Chemistry Section of the Central Association of Science and Mathematics Teachers, November 27, 1942.

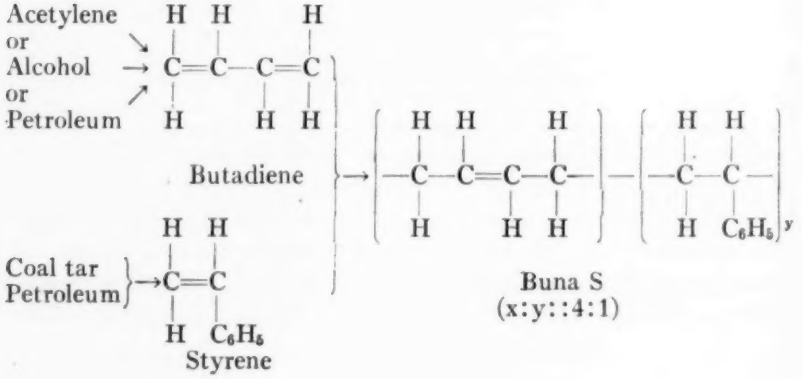
sulfur, the sulfur attacks some of the reactive double bonds in the isoprene units of rubber and the vulcanized rubber is far more resistant to becoming soft and tacky when hot, hard and brittle when cold. However, the chemical reactivity of the double bonds in the isoprene units also makes rubber susceptible to deterioration on exposure to air, sunlight and many strong chemical reagents. Furthermore, rubber softens, swells and dissolves in oils such as gasoline, kerosene, etc. The search for synthetic rubber has therefore been a search to synthesize a variety of custom-made substitutes for rubber which might be superior for one or more of the myriad uses of natural rubber.

One of the earliest successful substitutes was *Neoprene*. This material is prepared by polymerizing chloroprene.



Neoprene is quite similar to rubber in appearance but has superior resistance to abrasion, to deterioration in air and sunlight and to softening in contact with oils and greases. This has led to extensive use in such special applications as gaskets and hose for gasoline lines, conveyor belts, barrage balloons, etc. The production of Neoprene has more than doubled in all but one of its dozen years on the market and present plans call for expansion of production to 40,000 tons a year.

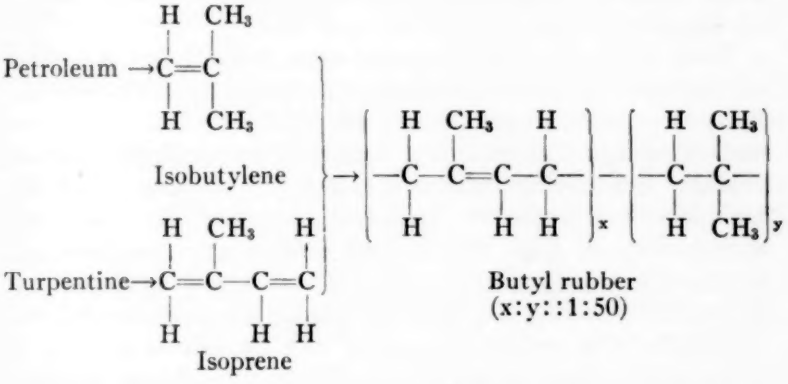
Really large scale synthetic rubber production will be con-



centrated on *Buna S*, a copolymer of styrene and butadiene. When a mixture of these two compounds is polymerized, the polymer formed is found to contain units of both styrene and butadiene, presumably in a random arrangement throughout the long polymer chain.

Present plans call for the production of over 400,000 tons of Buna S in 1943, over 700,000 tons in 1944.

A newer synthetic rubber is ***Butyl rubber***, a copolymer formed from a little isoprene and a lot of isobutylene. Just enough isoprene is added to give the polymer enough double bonds for vulcanization. Vulcanized Butyl rubber thus has no reactive double bonds and is extremely stable to chemical decomposition. Exposure to ozone or concentrated sulfuric acid, which completely disintegrates rubber, leaves Butyl rubber unaffected. Present plans call for the production of Butyl rubber at the rate of 132,000 tons a year.



In addition to these materials, which will make up the bulk of our synthetic rubber production, there are a host of other materials which can replace rubber for various special uses. These range from Thiohol, the pioneer American synthetic rubber dating from 1922, to Norepol, just out of the Northern Regional Laboratory of the Department of Agriculture.

Given several years of intensive experience in the production and compounding of all these various synthetic rubbers it seems safe to predict that the synthetic rubber industry will have developed products so economical and so superior that natural rubber may never recapture the position of prime importance it once occupied.

MATHEMATICS BASIC TO NAVIGATION*

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Just as "Pearl Harbor" found us unprepared in a military way so "Pearl Harbor" also found us unprepared educationally. Our educational leaders, in spite of the fact that we are living in a world that is daily becoming increasingly scientific and mathematical, have insisted that mathematics and science are both too difficult, too abstract, and too remote in their usefulness to be required of every boy and girl; consequently, mathematics and science have both had a decreasing emphasis in the secondary curricula of the country. It has taken a great calamity like a war to make us realize that in a civilization which is inescapably mathematical and scientific both mathematics and science do have a vital contribution to make to the education of American youth.

"The Army and Navy require that their flying personnel should have a good functioning basic training in mathematics. Because so many of the trainees do not have adequate mathematical background for flying, both the Army and Navy spend valuable time giving them this training, a training which the high schools are entirely competent to supply. By this is not meant that all high schools and mathematics teachers are equipped to supply all the mathematics needed in so specialized a function as flying a military airplane; the fundamental elements of mathematics upon which the specialized training is based, and without which it cannot be successful, can be given in high schools by high-school mathematics teachers." This quotation is from the U. S. Office of Education, *Leaflet No. 62*, issued last May. Newspapers and magazines have been full of stirring pictures of the inadequate training in these areas for the youth of our country. Publications, booklets, textbooks have been issued by the Navy and the Army outlining the type of material which is desirable for the education of youth. The following quotation from the War Department course in mathematics for pilot trainees is descriptive and typical of the others: "Briefly, the scope includes the elementary operations of arithmetic, such as, addition, subtraction, multiplication, and divi-

* Presented at the Mathematics Section of the Central Association of Science and Mathematics Teachers, November 27, 1942.

sion, percent, ratio and proportion, angular measurements, scales, the use of graphs and formulas, and the graphical solution of the more common problems involving the triangle of velocity." In further description of fundamental operations and methods of teaching, the War Department's bulletin makes the following statement: "Many of the problems are related to aviation (fuel supply, horsepower, revolutions per minute, air speed, alloys, gear ratios, etc.) but the stress throughout is upon (1) understanding the principles taught and (2) performing the operations accurately and quickly."

The Ground Training Syllabi of the Navy Department emphasize many of the same general principles, as does also the bulletin entitled "Education for the Air-Age" issued by the Civil Aernautics Administration.

It is not the purpose of this paper to review these recommendations of the Army, the Navy, and the Civil Aeronautics Administration. It is rather to suggest some of the basic problems which are involved and some of the important mathematical techniques which are utilized in aviation. Reference is made to the details in the outlines referred to above and to many of the books published for use in the new high-school course entitled Pre-Flight Aeronautics. Conspicuous among these books, one will find the AIR EDUCATION SERIES published by the Macmillan Company. One of these books is devoted entirely to the mathematics in aviation. This book is designed for the use of teachers, and while very inexpensive is invaluable because of the many suggestions which it makes.

Such problems as the following will make mathematics teachers realize how vitally important are the issues involved and how tremendously stimulating these problems can be to mathematics classes. Children who feel that their mathematics functions in the solution of problems such as the following will be not only thrilled but stimulated to learn their mathematics much more thoroughly than they could ever learn it by ordinary academic interests.

Problem No. 1. An aviator has enough gasoline to last for five hours. He starts out on a bombing objective and his ground speed out is 150 m.p.h. Due to the direction and velocity of the wind his ground speed back is 100 m.p.h. How far out can he go and return safely?

There are many ways of attacking a problem such as this. A simple way of arithmetic is very interesting. It would prob-

ably proceed something like the following: Suppose he went out for 1 hour. He would be out 150 miles and would have to return at the rate of 100 m.p.h. How long would it take him to return? Clearly, an hour and a half. What is the total time for which he would need a gasoline supply so that he could go out one hour? Evidently, two and one-half hours. With the rates indicated, therefore, his time out (1 hour) would be two-fifths of his total time (2.5 hours) available. Consequently, if he has five hours of gasoline supply he can evidently travel outward for two hours and have three hours to return to his base.

I have selected for this problem rates and times that would be simple to find. The aviator, however, does not always have such a simple solution as the one just given. Suppose, for instance, that an aviator has enough gas to travel for 12 hours and by computation he finds that his ground speed out in a certain direction is 153 m.p.h. and his ground speed back is 137 m.p.h. It is evident that in the solution of this problem no such simple result will be obtained. It is, therefore, also evident that one needs a more powerful analytic method than the simple arithmetic solution proposed above. The following simple algebra helps to make this analysis clear. For the sake of simplicity we will use the first problem in developing the algebraic solution and then apply it to the second.

It is desired to know how long the aviator may travel outward. Let us, therefore, let x be the time going out and $5-x$ the time returning. It is also evident that the distance out is equal to the distance back. Therefore,

$$150x = 100(5-x)$$

or

$$150x+100x = 500$$

$$250x = 500$$

$$x = 2.$$

Analysis: Apparently the 2 came from 500 divided by 250; the 500 came from multiplying 100, the speed returning, by the total time; and the 250 from the sum of the rates. Therefore, it would seem to be possible to generalize this specific solution to the effect that x equals the speed out times the total time, divided by the speed out plus the speed back.

Putting this in a formula, utilizing t_1 for the time going out, s_1 for the speed going out, s_2 for the speed returning, and T for

for total time we have the following generalization:

$$t_1 = \frac{s_2 T}{s_1 + s_2} = \frac{s_2}{s_1 + s_2} \cdot T.$$

A rigorous mathematical development of this formula follows:

$$\begin{aligned} s_1 t_1 &= s_2 (T - t_1) \\ &= s_2 T - s_2 t_1 \\ s_1 t_1 + s_2 t_1 &= s_2 T \\ t_1 &= \frac{s_2 T}{s_1 + s_2} = \frac{s_2}{s_1 + s_2} T. \end{aligned}$$

Furthermore, the distance out or the "radius of action" will be $t_1 \cdot s_1$ or,

$$R = t_1 s_1 = \frac{s_1 s_2}{s_1 + s_2} T.$$

Application in second problem:

$$t_1 = \frac{137}{153 + 137} \cdot 12 = \frac{137 \cdot 12}{290} = 5 \text{ hrs. } 40 \text{ min.}$$

$$R = \frac{153 \times 137}{153 + 137} \cdot 12 = 867 \text{ miles.}$$

The following techniques, long division to get time in hours and minutes and multiplication and division by logarithms, are suggestive of useful variations.

5 hr. 40 min.

290)1644

1450 —5 times 290

194 —Numerator of fractional hour.

×60 min.

11640 —Numerator of fractional minutes.

1160 —4 times 290

40

log 137 = 2.1367

log 153 = 2.1847

$$\log 12 = 1.0792$$
$$\operatorname{colog} 290 = 7.5376 - 10$$
$$\log R = 2.9382$$
$$R = 867 \text{ miles}$$

It is evident from this problem that many very useful mathematical techniques are basic and necessarily involved. Of course, without computation it would be futile to attempt to solve this problem. Furthermore, the ability to analyze a situation, to generalize a solution into a formula, to understand and appreciate the functional relationship which exists among the quantities involved are mathematical objectives of no mean significance. A mathematics teacher who fails to utilize problems of this kind in hearty preference to coin and age problems that infest our algebras is failing to be alert to the educational possibilities of his subject.

Suppose this afternoon I were starting by plane to go back to Cincinnati. There is a strong west wind blowing, about forty miles per hour. Cincinnati is approximately on a course 140° from Chicago; this is the terminology of the navigator. A course of 140° means traveling at an angle of 140° with a true north-south line. Angles in navigation are always measured from the north-south line in a clockwise direction. This is contrary to our traditional teaching of the direction in which a positive angle is measured. Consequently, mathematicians must demonstrate that they have the ability to adjust themselves to current practice rather than to force current practice to change its preferred techniques to correspond with our traditional ones. It is, of course, evident that there is a reason why the navigator measures his angles from the north, and that is, of course, because the compass points north, and it is much more convenient to measure angles from the north than from any other position.

Let us solve the problem relative to navigating a plane to Cincinnati by considering it as two problems. First, let us assume that the navigator disregards the wind and merely holds his plane at an angle of 140° towards Cincinnati. Will he reach Cincinnati? Let us assume further that we have a wind slightly from the southwest, or as a navigator would say, from 240°. In order to solve these problems, scale drawing must be utilized and also a protractor to measure angles.

Problem 1.

air speed = 160 mi/hr.
course 140° (also heading)
wind from 240° rate 40 mi/hr.
Scale: 1 cm = 20 mi/hr.

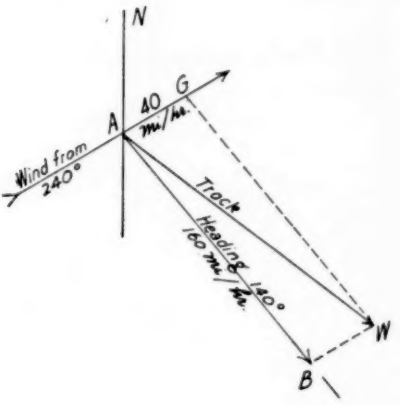

FIG. 1. (Reduced about one-half)

Soution by scale

AB, the track, = 8.6 cm.
Ground speed therefore = 172 mi/hr.
Drift angle $BAW = 12°$

In Figure 1, AG represents the direction that the navigator heads the plane and the speed of air travel; that is, the distance traveled in one hour. It is evident, without any knowledge of laws of physics, that the plane would be blown off the course and would go to the left. We are told in physics that the actual path of the plane would be represented by the diagonal of a parallelogram of which the two sides are the two forces acting on the plane. Consequently, AB in the drawing represents both the distance that the plane travels in one hour and the actual path or "track" of the plane. As measured with a protractor, the drift angle is about 12° and the actual ground speed 172 m.p.h. It is evident that this heading would never permit the plane to reach Cincinnati. It is also evident that the plane must head to the right of the course to Cincinnati in order to be blown over on the course. In other words, the line representing the course must be the diagonal of the parallelogram instead of

one of the sides. Figure 2 represents the solution of this problem by a navigator.

Problem 2.

air speed = 160 mi/hr.
course 140°
wind from 240° rate 40 mi/hr.
Scale: 1 cm = 20 mi/hr.

With G as a center and radius 160 mi. locate W on course AC. Results:

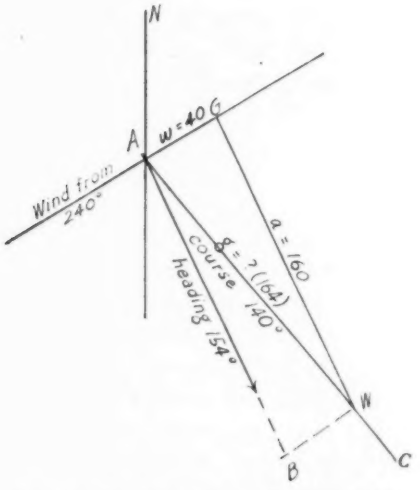

FIG. 2. (Reduced not quite one-half).

wind correction angle = 14°
heading 154°
ground speed AW (to scale— 164 mi/hr.)

It is evident from these drawings that a pilot must head his plane, as he faces Cincinnati, to the right of the course; that is into the wind, in order to be blown over on the course. According to the drawings, this wind correction angle is 14° as measured by a protractor. The length of the line $A\ C$ is such as to suggest a ground speed of 162 m.p.h. Really, this is a beautiful problem in geometry involving measuring angles, getting proportions so as to make the proper scale, and drawing conclusions in accordance therewith. A more accurate solution can be given by trigonometry, using the sine law. It follows:

Trigonometric solution for Problem 2.

In triangle AGW use the sine law:

$$\frac{\sin W}{40}=\frac{\sin A}{160}$$

$$\sin W=\frac{40 \sin (140^\circ-60^\circ)}{160}$$

$$=\frac{40 \sin 80^\circ}{160}=\frac{.9848}{4}$$

$$W=14^\circ 15'$$

$$\frac{AC}{\sin G}=\frac{160}{\sin A} \quad \text{or} \quad \frac{AC}{\sin 85^\circ 45'}=\frac{160}{\sin 80}$$

$$AC=\frac{160 \sin 85^\circ 45'}{\sin 80}$$

$$AC=162 \text{ miles.}$$

From the trigonometric solution, it is evident that the wind correction angle is 14°15′ and to the nearest mile the ground speed is 162 m.p.h. This illustrates the relative accuracy of the methods of solution. Of course, if the scale drawing were made larger and very, very accurately with a fine pencil, closer results could be obtained. But since the trigonometric solution takes such a very short time, it would seem to be sensible to check the solution by means of trigonometry to get the exact angles and distances involved. Knowing that the plane is able to travel at the rate of 162 m.p.h. the time of its arrival in Cincinnati can be predicted with considerable accuracy. Actually, the results are no more accurate than the original data. The velocity of the wind was taken from the morning paper on the day this problem was presented.

In thinking through the diagram which is involved in solving this problem, concerning the heading of a plane in order to effect a certain course, one of my tenth grade geometry students made the following comment: "The actual course that would be followed would be just the same as though the wind had stopped blowing for an hour and the plane had traveled in a certain direction, then the plane had stopped for an hour and let the wind blow in its direction for an hour." The net effect of these two forces in sequence would be the same as having the forces acting simultaneously. This thinking would, of course, assume

that the plane by some magic could stay up in the air for an hour while the wind was blowing it over. The net effect of these two actions would be to arrive at point W in the second figure, making AW the resultant of the two forces AG and AB on the plane leaving from point A.

It is easy to see that these two typical air navigation problems involve some beautiful mathematics: arithmetic, algebra, geometry, trigonometry, and seem so fundamental in their importance that it would not seem difficult to justify their inclusion in the education of every boy and girl, even though they may not be navigators of airplanes. The following problems are also typical of some of the simpler types of computations that are constantly involved in aeronautics, including navigation.

1. The fuel consumption at cruising speed of a St. Louis PT-1 is 13.9 gal. per hour. Its fuel capacity is 42 gal. How many hours could this plane travel and have a reserve of 25 per cent of its fuel?
2. The Ryan St-3 has a fuel capacity of 24 gal. Its normal range is 325 mi. Find the number of miles per gallon.
3. A plane is scheduled to leave San Diego daily at 9:30 A.M. It is scheduled to arrive at Seattle, a distance of 1,214 miles from its starting point, at 7:52 P.M. What is the rate of travel in miles per hour?
4. If the time required to cover a 10 mile track section is 3 min. 48 sec., how long will it take to complete the journey to your destination 165 miles along the track? Solve graphically.
5. A plane can "dust" 300 acres of cotton per hour. An average of 3 pounds of chemicals are used per acre. If the plane operates 5 hours on one trip, how many acres will it dust and how much insecticide will it use?
6. The escudo has an average value of \$0.04. If the bill for dinner for 30 passengers and 12 crew members on the Atlantic Clipper was 1,562 escudos at a restuarant in Lisbon, what was the cost of this meal in dollars? per person?
7. The weight of the Boeing Clipper fully loaded is 84,000 pounds. The fuel capacity is 5,400 gallons. What per cent of the total loaded weight is the weight of the fuel?
8. The rate going from A to B was 125 m.p.h. The rate returning was 110 m.p.h. The flying time required for the

round trip was 4 hours. Find the distance from A to B. Find the average rate for the trip.

9. A plane flying north at an average air speed of 150 m.p.h. is aided by a tail wind of 20 m.p.h. velocity. How long will it take the plane to complete a trip of 550 miles?
10. Find the great-circle distance between Ogden, Utah, lat. 41°13′N., long. 112°W., and Oklahoma City, Oklahoma, lat. 35°29′N., long. 97°30′W.
11. A scouting plane sets out on a mission from a carrier steering a constant course 95° at 25 m.p.h. The plane heads 45° and is to maintain an air speed of 120 m.p.h. There is a wind of 15 m.p.h. velocity from 275°. Find the course out, the ground speed out, the course and ground speed back, rate of departure, the rate of return and the time out to the turn if the plane is to return to the carrier after 2 hours' flying.

Most of the problems listed above were taken from the Macmillan Air-Age Series book, *Mathematics in Navigation*. They are typical of commonly occurring problems and suggest the great importance of proportions in all sorts of navigation problems. They also suggest the great utility of the slide rule in the solution of such problems. The slide rule is probably without question the most rapid calculating instrument yet devised by the mind of man and is perfect and very simple in the solution of such proportions as are involved in navigation. Usually the data does not have more than three-place accuracy, consequently the slide rule is amply accurate for such computations.

Mathematics teachers can well consider making such revisions in their course offerings and in the materials included in those courses as to make them function more adequately in this age of flight. It would seem rather difficult to justify the traditional problems dealing with Mary's age and George's age, dealing with the values and numbers of coins in one's hand, and that sort of a futile uselessness which too often still marks the algebras of even recent years. Then too, the great emphasis by our war leaders upon understanding of the principles and concepts utilized should have a dominating influence on the methods used in teaching mathematics to young people. Mathematics can be made concrete and simple. It can be made meaningful and functional. It is and ever will be widely useful in a variety of activities; not only in navigation, but in the machine shops, in

the factories, stores, highways, science laboratories, research activities, and even in the solution of many social and economic problems. As mathematics teachers it is up to us now so to utilize the tremendous impetus that has been given the teaching of mathematics and the learning of mathematics that our subject may function adequately, completely, and understandingly in the lives of American youth.

NOTES FROM A MATHEMATICS CLASSROOM

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(*Continued from the February issue*)

41. The Course in Solid Geometry. Ten or fifteen years ago the dissatisfaction with solid geometry was so pronounced that many teachers advocated abandoning the course and introducing significant parts of it in plane geometry. Book Six was considered of some value but the proofs of the formulas for areas and volumes were thought to waste time. Because the work on limits could not be so rigorous as a college course in calculus, some teachers advocated omitting the work on limits, forgetting that any introduction to limits must have weak spots.

The 1940 Report of the Joint Commission on Mathematics contained, page 115, a few good words for the course since the engineering schools continued to demand it. The Report mentions "some significant and sometimes forgotten merits," namely:

1. The value of Book Six as a means of teaching more about logical thinking.
2. The opportunities for algebraic work on radicals, for manipulation of algebraic expressions, and for expressing one variable in terms of others.
3. The opportunities for computational work with logarithms and for organizing long pieces of computational work, as in the problem: Find how many inches of rainfall are equivalent to the water from a hose through which the water flows for an hour at the rate of 10 gallons per minute and spreads over a circle whose radius is 12 feet.
4. The opportunities for teaching freehand sketching.
5. The work on loci and the introduction to coordinates.
6. The introduction to limits.

When I first taught a class in solid geometry I was greatly disappointed because, after proving a theorem, I could not find suitable exercises which involved that theorem. In plane geometry after proving a congruence, or any other, theorem, I could assign exercises that would involve the theorem. But in solid geometry each theorem seemed merely a preparation for another theorem or an isolated fact. I was also disappointed with the pupils. Since a third semester of algebra is a prerequisite for the course I expected the pupils to handle literal equations and radicals easily. I expected them to use logarithms since that topic was taught in the previous course in algebra.

Only after teaching the class a number of times did I learn that I could make the course valuable to the pupils by treating it almost as a remedial or review class. We studied and proved neglected theorems of plane geometry. Whenever a theorem of plane geometry was quoted, we reviewed that theorem. When a theorem resembled a theorem from plane geometry we studied the similarities. We reviewed all the work on radicals, and when we reached spherical segments we reviewed work on sets of quadratics. Once again we proved Hero's formula.

To do this review work and to include the new material, we were forced to assume some of the theorems of solid geometry. Thus we treated briefly "Jacob's Coffin," that is, the theorem about the volume of any parallelopiped and the four or five theorems that lead up to it. And only enough work on spherical triangles was included to provide for the theorem about the area of a spherical triangle. We omitted the theorems about the congruence of spherical triangles even though they were listed as required by college entrance examinations.

42. Solid Geometry and the War. All high school mathematics is influenced by the war. But ninth and tenth graders are far from the draft age and few of them expect to see service in the armed forces. In the eleventh grade we now find many boys in the trigonometry classes who have no aptitude for mathematics and only a feeling that mathematics has suddenly become useful. But the content of trigonometry will not be greatly influenced since it has always included the foundation for the problems which the war department says should be studied. The course hardly needs revision merely to include some work on the *mil*. The course in solid geometry, however, offers a magnificent opportunity to do something new and truly useful to future soldiers.

This semester I do not have a class in solid geometry; but if I did, I would plan it as follows:

For once I would omit the work on limits—because I can thereby save time for other topics which, temporarily, are more useful. I must therefore omit any attempt to prove certain formulas about areas and volumes of cones, cylinders, and spheres. But I would do enough work with models to make the formulas seem reasonable and understandable. I might even resort to the eighth grade methods of finding the volume of a triangular prism by pouring sand into a paper model; and I could treat the volume of a cone in a similar manner. But I would include and do thoroughly the theorems which involve algebraic work, such as finding the volume of frustums and of spherical segments.

I should like to include:

1. Book Six, as usual, since it is essential to an understanding of lines and planes in space.

2. More work on computations with and without logarithms. I note that in Buchan's text on *Aviation Mathematics* (which I consider the best of its kind for high school classes) there are many drill problems so complicated that I hesitate to ask the printers of this journal to set them into type.

3. Four or five weeks on trigonometry. Usually more than half the class has credit in trigonometry; even if I wasted some of the time of some of these pupils, I would begin at the beginning, study the law of sines and tangents, and half-angle formulas (derived geometrically in this case). Then I hope we could do enough work on spherical trigonometry to show how the distance between two points on the earth is computed.

4. Some work on astronomy. The pupil would at least become familiar with such terms as right ascension, declination, azimuth, the celestial equator, coordinate systems used to locate heavenly bodies, and what is called nautical astronomy. In this connection, a splendid text is Bradley's *Mathematics of Air and Marine Navigation*.

According to this plan I would have the course consist of about one third solid geometry, one third trigonometry, and one third astronomy. This is strictly an emergency measure. When the war is ended I would return to my previous course, teaching trigonometry in the trigonometry class, and leaving astronomy to the astronomy class.

43. Ninth Grade Algebra and the War. The changes in algebra due to war depend on what the teachers were doing before

Pearl Harbor. The government publications that I have seen indicate that we must give up the soft, easy stuff which has masqueraded under the name of algebra and present some real, honest, tough, severe, difficult, brain-racking, thought-provoking, laborious, unpleasant, and rigorous algebra. The *Refresher Mathematics*, written by the navy, which I used as a text last semester with a group of seniors, contains fractional exponents, complex fractions, addition of fractions with trinomial denominators, nests of parentheses, and in fact everything that we have been told for many years to discard. And another "Teaching Aid," sent out from Washington, includes problems like this one:

$$H = 0.00307\left(fSV^{n+1} + b\frac{D^{2/3}}{L}V^5\right).$$

Compute H when $f = 0.09000$, $S = 67{,}550$, $V = 25$, $n = 1.83$, $b = 0.35$, $D = 28{,}600$, $L = 700$ (Answer: $H = 30{,}880$).

No junior or senior will feel inclined to tackle that problem unless he has been taught to work in the ninth grade. I note that none of these texts include any work on drawing pictograms or histograms to show, for example, the number of bales of cotton grown in the last decade. The graphical work involves making the graphs of equations, and the reverse problem of knowing how to get facts from a complicated graph already drawn.

Undoubtedly the best solution will be to put more ninth graders into classes in General, Basic, or Social Mathematics. Then in the tenth or eleventh grade, the better pupils can study the kind of algebra that Washington is asking us to teach. Real algebra must as usual be offered also in the ninth grade for the sake of those who can learn it. The small schools that cannot offer both courses are unfortunately in the same position as the small manufacturers who are well equipped to do business in peace but not equipped to manufacture munitions. I feel sure that attempts to remedy the situation will be made in the usual way: more work for teachers.

A SAFETY SWITCH FOR LAND PLANES

Land planes forced down at sea may now be equipped with a device which automatically opens a hatch, inflates a rubber boat, and ejects it ready for use. A switch is thrown when the plane's belly hits the water, this releases compressed carbon dioxide which forces open the hatch and inflates the life-raft in seven or eight seconds.

SCIENCE IN THE NEWSPAPER*

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A question constantly raised by teachers and others interested in education is "What should be taught?" Since the volume of human learning is almost beyond comprehension, educators must constantly select that which is thought to be most fundamental and indispensable.

This problem of selection of content exists in a relatively acute form in the field of natural science. Under this head are found such specialized branches as botany, horticulture, agriculture, paleontology, medicine, physiology, geology, astronomy, anthropology, cytology, chemistry, spectroscopy, and meteorology. Other fields can readily be added.

In this so-called scientific age, most thinking individuals agree that instruction in science should play a significant part in the program of the schools. Obviously not all of the specialized sciences can be taught. The question to be answered is, "What and how much of each of the many sciences should be taught to the average person who is not a science specialist?"

In many secondary schools, instruction in general science for all students is increasing rapidly. In colleges the usual requirement has been the taking of a certain minimum of work in one of the specialized sciences. One criticism of the collegiate plan has been that the non-science specialist, in taking intensive work in only one branch of science, lacks comprehension of the entire field. There have been increasing of late "integrated," "survey," and "general science" courses in colleges.

In reply to the question as to what should be included in science instruction for the non-specialist, it frequently has been suggested that analyses be made of what people generally read, such as newspapers, popular periodicals, and popular books. It should be strongly emphasized that such a study in itself is not considered to be the sole determiner in constructing a course of study in science, but it should have weight. It was planned in this study to determine the kind, amount, and rate of change of science material in the *New York Times* over a period of years.

Newspapers and periodicals have been analyzed for their

* From dissertation for degree of Doctor of Education entitled "An Analysis of the Science Content of the *New York Times* and of Selected General Science Textbooks." Temple University, Philadelphia, 1942.

science content by a number of investigators. Most of the studies, however, have been decidedly limited in scope and significance. Finley and Caldwell,[1] about twenty years ago, measured and classified the biology in selected urban and rural newspapers, Curtis,[2] in 1924, basing his work in part on the newspaper articles of Finley and Caldwell, investigated the scientific knowledge required for an intelligent reading of the public press.

In the present study, it was at first planned to analyze and compare the science content of several newspapers over a ten-year period. It soon became apparent, however, that the task would be too extensive. For this reason it seemed advisable to limit the investigation to a more intensive study of one newspaper. The *New York Times* was chosen because of its large numerical and geographical circulation, and its wide recognition for intrinsic worth.

Four years were analyzed completely. The years selected for study were 1930, 1933, 1936, and 1939. Every page of each paper was scanned, including the special departments of the Sunday edition. Omitted were advertisements, daily weather maps (introduced in 1934), daily weather forecasts, and crop reports. In all, forty-eight months, or 1,461 newspaper issues were studied, covering a total of an estimated minimum of 75,000 pages.

The analysis was not limited to articles devoted strictly to science, but also included those devoted only in part to it. The length of the scientific reference was measured in column-inches and recorded on an index card. In order to eliminate passing references, such as names of diseases, the writer adopted an arbitrary minimum of one-half column-inch for inclusion of any reference. The analysis was detailed, one article often being separated into several elements, depending upon its content. A single article on a medical subject, for example, might include a description of a disease, information on the chemical synthesis of specific drugs, and an outline of the preparation of vaccines. Thus the article would not be recorded as one unit, but its length would be divided among the respective fields indicated.

Only that part of the article or reference was measured which

[1] Finley, Charles W. and Caldwell, Otis W.: *Biology in the Public Press.* New York: Lincoln. School of Teachers College, 1923. (From Francis D. Curtis: "A Digest of Investigations in the Teaching of Science," pp. 259–264. Philadelphia, P. Blakiston Son and Co., 1926).

[2] Curtis, Francis Day: "Some Values Derived from Extensive Reading of General Science," pp. 10–27. Contributions to Education, No. 163. New York: Teachers College, Columbia University, 1924.

met the subjective criterion of being material which was likely to be found in a science textbook or reference book. If it had not been for this restriction, it is likely that material on weather, for example, would have been most voluminous in the completed analysis, instead of its occupying a position of moderate importance. It was considered preferable in measuring, therefore, to delete unrelated material of a political and circumstantial nature, despite the consequent necessity of having to introduce the factor of subjective estimate.

As a check upon the reliability of the study, three months were selected at random from the forty-eight months in the complete newspaper analysis, and these three months were analyzed completely and independently for a second time. The months chosen were August, 1933, January, 1936, and May, 1939. The deviations in volume between the first and second analyses averaged three and seven-tenths per cent. It would seem reasonable on this basis to assume the analysis to be reliable within the limits indicated by this check.

The completed analysis resulted in a total of approximately 375 topics, some of which were later combined, giving a final total of 185 topics. The 185 topics were classified into fifteen major-topics for purposes of study and comparison.

In attempting to determine the fifteen major-topics, many science textbooks were examined for their chapter names, unit organization, and the like. The classification as finally made, however, was suggested chiefly by the nature of the newspaper science.

The major-topics, with the newspaper volumes by years, are shown in Table I.

As indicated in Table I, 52,238 column-inches of space were devoted to science during the four complete years of the *New York Times* analyzed. The total volume found in 1930 was approximately the same as in 1936. The volume in 1933 was less than in either of the years mentioned. The volume for 1939 was smallest, being approximately thirty per cent less than in 1930, the year for which the maximum was recorded. Whether or not this falling off in volume during 1939 was significant, is problematical. It may be a fluctuation and not indicative of a trend.

For comparisons of trends within the various major-topics, as well as other analyses, it seems preferable to compare proportions of volumes, rather than absolute amounts of newspaper

TABLE I

Volumes in Column-Inches in New York Times

Major-Topic	*1930*	*1933*	*1936*	*1939*	*Totals*
1. Health and Medicine	2,839	2,550	3,133	1,965	10,487
2. Communication and Transportation	1,816	942	1,012	757	4,527
3. Animal Life	1,428	1,098	1,064	662	4,252
4. Man and Behavior	1,289	982	993	592	3,856
5. Gardening and Agriculture	406	440	1,743	1,027	3,616
6. Earth Science	1,287	979	584	563	3,413
7. Weather and Forecasting	796	806	1,161	619	3,382
8. Applied Chemistry	674	614	722	1,163	3,173
9. Atomic Investigation, etc.	834	886	873	478	3,071
10. Astronomy	1,032	719	548	545	2,844
11. Forms of Energy, Applications	645	715	552	624	2,536
12. Conservation	492	594	854	269	2,209
13. Plant Life	591	373	639	375	1,978
14. Principles of Chemistry	428	387	478	503	1,796
15. Mechanics	355	247	241	255	1,098
Totals	14,912	12,332	14,597	10,397	52,238

space. For this reason, Table II, indicating the per cent of the total space devoted to each major-topic, is presented.

TABLE II

Major-Topics in Per Cent of Total Science Volume

Major-Topic	*1930*	*1933*	*1936*	*1939*	*Average*
1. Health and Medicine	19.0	20.7	21.5	18.9	20.1
2. Communication and Transportation	12.2	7.6	6.9	7.2	8.7
3. Animal Life	9.6	8.9	7.3	6.4	8.1
4. Man and Behavior	8.6	8.0	6.8	5.7	7.4
5. Gardening and Agriculture	2.7	3.6	11.9	9.9	6.9
6. Earth Science	8.6	7.9	4.0	5.4	6.5
7. Weather and Forecasting	5.3	6.5	8.0	6.0	6.5
8. Applied Chemistry	4.5	5.0	4.9	11.2	6.1
9. Atomic Investigation, etc.	5.6	7.2	6.0	4.6	5.9
10. Astronomy	6.9	5.8	3.8	5.2	5.4
11. Forms of Energy, Applications	4.3	5.8	3.8	6.0	4.9
12. Conservation	3.3	4.8	5.9	2.6	4.2
13. Plant Life	4.0	3.0	4.4	3.6	3.8
14. Principles of Chemistry	2.9	3.1	3.3	4.8	3.4
15. Mechanics	2.4	2.0	1.7	2.5	2.1

It will be seen that about 20 per cent of the total newspaper space for science is devoted to Health and Medicine; this is more than twice as much volume as is devoted to the next highest major-topic. Furthermore, the proportion of space devoted to Health and Medicine remained practically constant during the four-year sampling of the ten-year interval covered in the

newspaper study. Cancer is the disease receiving the greatest newspaper attention. Alcoholism was a prominent feature in 1930, but showed a rapid decline following the repeal of prohibition in 1933. It is interesting to note that venereal disease received no mention at all until 1936, but has been increasingly featured in the newspapers since then.

The attention given to Communication and Transportation declined in 1933 from its 1930 level, thereafter remaining fairly constant. This sudden falling off in 1933 is explained to a large degree by the interest shown in the activities of several large dirigibles in 1930. Radio is the sub-topic receiving the greatest newspaper space under Communication and Transportation. The amount of technical material on radio decreased from 1930 to 1939, although approimately the same space was given to radio and broadcasting. Apparently as the radio industry became more stabilized, the technical phases no longer were given as much attention as they were earlier.

There was a slight, but definite falling off in the space devoted to Animal Life, during the four years studied. The proportion devoted to this topic in 1939 was one-third less than in 1930. A similar gradual decline was shown in Man and Behavior and in Earth Science. The material under Animal Life dealt chiefly with descriptions of animals and their habits. Insects and their control was the most important sub-topic, followed by birds and migration.

The newspaper devoted an appreciable share of its attention to man, his psychology, and the bearing of science upon his living. This comprised the major topic, Man and His Behavior. Biography of scientists, and historical material were thought to belong more properly under this topic, rather than any other. Ethnology and archeology were, after much hesitation, omitted as being more likely to be included in the social science field. Anthropology was the most voluminous sub-topic under ethnology.

The topic, Gardening and Agriculture, increased in 1933 slightly over 1930. In 1936 it increased more than four-fold over 1933. The explanation for this was that a Sunday gardening section was begun in 1934. Since Sunday editions of large newspapers have a large sale in suburban and rural areas, this section was probably introduced for the benefit of the suburban and rural reading public. The Sunday Gardening and Agriculture Department was not a feature limited, however, to the *New*

York Times. It was found also in the *New York Herald Tribune*, *Chicago Tribune*, *Philadelphia Inquirer*, and *Philadelphia Record*. Most of these papers had introduced the department before 1930. It seems reasonable to assume that Gardening and Agriculture is figured in Sunday papers of large circulation generally, and is not peculiar to the *New York Times*.

Attention to Earth Science showed a general decline between 1930 and 1939. The declining attention was especially noticeable with respect to earthquakes, paleontology, caves, and earth strata.

Weather and Forecasting included clouds, humidity, and fog as well as winds and storms.

Much of the chemistry material in the newspaper is in the applied field, and is usually presented with the assumption that the reader possesses a broad background of chemistry. After remaining fairly constant during 1930, 1933, and 1936, the importance of Applied Chemistry as measured by volume of space increased in 1939. Sub-topics which markedly increased were synthetic textiles, plastics, and photography. Considerable attention was given to the testing and preservation of food. Applied Chemistry will probably continue to grow in newspaper importance.

Grouped together under Atomic Investigation and Theoretical Physics were atoms and "atom smashers," cosmic rays, radium and radioactivity, x-rays, and theories such as relativity.

More space was devoted to Astronomy in 1930 than in any of the subsequent years. The explanation for this is the discovery of the new planet, Pluto, during that year. The distribution of space among the other sub-topics remained comparatively constant during the four years studied.

Since the space devoted individually to light, heat, sound, and electricity was comparatively small, these fields were all placed together under the major topic Forms of Energy and Applications. In comparison to the attention given to sound in most general science textbooks, the space devoted to it in the newspaper is very small.

Conservation attained its greatest importance during 1936, a year of severe drought. There was marked newspaper interest then in dust storms, erosion, and their control. The whole topic of conservation fell off greatly in the newspapers during 1939.

Under Plant Life, slight attention was given to lower plant forms, excepting yeasts and mushrooms. Trees and wood prod-

ucts occupied a position of importance in this major-topic. Botany in the newspaper was chiefly concerned with gardening and agriculture, topics which have received separate treatment under Gardening and Agriculture.

Under Principles of Chemistry, emphasis upon organic chemistry increased between 1930 and 1939. As indicated earlier, the chemistry in the news dealt more with applications than principles. The references to principles were usually brief, often assuming a basic knowledge of chemistry on the part of the reader.

The emphasis upon mechanics, while comparatively small, was fairly consistent throughout the years studied.

Although the determination is not exact, it is possible to estimate the approximate proportion of space devoted to biological science, and the proportion devoted to physical science by combining the per cents shown in Table II. Health and Medicine, Animal Life, Man and Behavior, Gardening and Agriculture, Conservation, and Plant Life, were combined under Biological Science, while the remaining nine major-topics were combined under Physical Science. The results are indicated in Table III.

TABLE III

Per Cent of Space Devoted to Biological Science and Physical Science

	1930	*1933*	*1936*	*1939*	*Total*
Biological Science	47.2	49.0	57.8	47.1	50.5
Physical Science	52.8	51.0	42.2	52.9	49.5

During 1930, 1933, and 1939, the proportions are comparable, the physical sciences receiving slightly more attention than the biological sciences. In 1936, however, the biological sciences were appreciably greater than the physical sciences. The distribution in 1936 is probably to a large degree explained by the increased attention given to conservation because of the drought, and the introduction of the Gardening Section.

The average for the four years indicated that the space devoted to the biological sciences was almost equal to the space devoted to physical science.

SUMMARY OF FINDINGS

1. Of the fifteen major-topics in science, Health and Medicine had most space devoted to it during each of the four years of the *New York Times* analyzed. This topic averaged 20.1 per cent, or about one-fifth of all the space devoted to science. This

was well over twice as much space as was devoted to second ranking Communication and Transportation.

2. The per cent of space devoted to Applied Chemistry, and Gardening and Agriculture, showed progressive increase during the four years studied. The per cent of space devoted to Animal Life, Man and Behavior, and Earth Science showed progressive decrease. No definite trends were found for the remaining major-topics.

3. Approximately 50.5 per cent of the newspaper space was devoted to biological science, and 49.5 per cent was devoted to physical science.

Recommendations

As an outgrowth of this investigation, it seems desirable to make the following recommendations:

1. Similar analyses should be made of the science content of other newspapers, and of both general and popular science magazines.
2. The science appearing in radio programs and the motion pictures might well be analyzed with a vew to determining its kind and accuracy.
3. The use of "Science" as an aid to advertising should be analyzed to determine the accuracy of the science appearing there, such as the study reported by Cox, McCollum, and Watkins,[3] but on a larger scale.
4. More comprehensive studies of the science vocabulary of newspapers should be made to supplement existing studies, most of which were made fifteen or more years ago.[4]
5. Instruction in science on all grade levels can be greatly enriched by the production of pertinent items in "current science," as they appear in newspapers.

It should be reiterated that the results of a newspaper analysis cannot be used as a sole basis for setting up courses of study. They are to be recommended, however, as one of the sources of relatively objective material. Combined with analysis of other periodical literature, the results cannot be ignored by curriculum specialists.

[3] Cox, Treffie, McCollum, J. S., and Watkins, Ralph K.: "Science Claims in Magazine Advertising," *Science Education*, Vol. 22, January, 1938, pp. 14–19, February, 1938, pp. 85–87.

[4] Curtis, Francis D.: *Investigations of Vocabulary in Textbooks of Science for Secondary Schools* (A Compilation of most of the significant vocabulary studies in Science.) Boston: Ginn and Co., 1938.

CHEMISTRY IN WAR

L. H. Reyerson
University of Minnesota, Minneapolis, Minnesota

In the period up to 1914 when World War I began, the United States occupied a relatively weak position in the world of chemical industry. It is true that a reasonably strong inorganic chemical industry did exist but almost nonexistent was an industry based upon the developments in research laboratories. In fact outside of university and government laboratories very little research in the field of chemistry was in progress. Many students felt that it was necessary to attend European universities in order to receive proper training in this fundamental field of science. During the four years of war it was clearly demonstrated that the United States had been dependent upon outside sources for more than forty materials that were essential to the welfare of the country. Some of these strategic materials became vitally important when the United States entered the war in 1917. American chemists and chemical engineers made the important decision that if it was in their power to do so, they would free the country from foreign domination in this all important phase of our industrial life. As a result new fields of fundamental research were entered by American scientists and numerous research laboratories were established. In fact there are now more than two thousand such laboratories where in 1908 there were but three. Researches in these laboratories have given this country a major synthetic chemical industry. Drugs, medicinals, and dyes were largely imported prior to 1914; today there are practically no imports of these substances and large quantities are exported. It has often been said that World War I gave America her important chemical industries and made her people chemically conscious.

Technology and Tanks

War demands a great deal from chemistry and metallurgy. Chemical and metallurgical engineers must create most of the sinews of war. Explosives, metals and their alloys, together with petroleum products, provide the principal materials which the Army and the Navy need to fight efficiently and effectively. In addition the armed forces must be able to protect their troops against poison gas and other hazardous chemicals. They must also be trained to use these same types of materials against the

enemy. In the present conflict, victory is most likely to go to that side which has and uses the latest scientific and technological developments. As a recent article in *Fortune* magazine puts it, a real technological high command is essential for victory. Pearl Harbor was not a good example of the proper use by Americans of the latest scientific developments.

Too many of our citizens think of chemistry in warfare as being concerned only with gas warfare. Even the Army assigns this type of warfare to the Chemical Warfare Service whose duty it is to train troops in gas warfare, handle the dispersal of chemical agents, and direct the armed forces in the protection of their own men. This branch of the Army also develops and uses incendiaries and smokes. However, chemistry is intimately connected with all of warfare, not merely this phase called chemical warfare.

For example, modern armies move and fight with petroleum products. Here the United States has a real lead over the enemy. In addition to controlling over 60 per cent of the world's production of petroleum this country has the world's leading petroleum chemists. The developments of the cracking of oil, the polymerization of small hydrocarbon molecules to form high octane motor fuels, the hydrogenation of unsaturated hydrocarbons, and the synthesis of isooctane all occurred in this country. It has been said that the petroleum chemist can do almost anything he wants to with the molecules in crude oil. About seventy-five per cent of the crude oil is now converted into gasoline and it is reported that one pilot plant can start with one thousand barrels of crude oil and end up with one thousand and ten barrels of gasoline with nothing left over. This is done without violating the law of the conservation of mass. Already gasolines are being made that have an octane rating of one hundred and fifteen for the best aircraft and the chemists in this field now talk of one hundred and fifty octane motor fuels.

Flying Metals

Similar progress is being made in the field of light alloys but here such a distinct lead over the Axis does not exist. Production of aluminum had risen during the fifty years which followed Hall's discovery to about 300 million pounds annually; war has pushed it up another seven-fold until there will be a production of over two billion pounds next year. The expansion of magnesium production is still more startling. Less than a decade

ago only a million pounds of this light metal were made annually. The demands of aircraft for alloys of magnesium and aluminum became so prodigious that 400 million pounds were demanded for 1942. This figure will not be met but already there is talk of doubling it for 1943. No one connected with these developments in light metals and alloys believes for a moment that the country will return to a pre-war rate of production when the war has ended. With confidence it is predicted that ample use for them will be found in many phases of post-war expansion based on new creations by science and technology. New motor fuels and the light alloys together with plastics will be combined to make the present motor car obsolete. Post-war transportation by train, by car, and by plane will be as radically different from the transportation of 1940 as that differed from 1914.

Block-buster Chemistry

Everyone knows that armies need explosives to fight but few realize the complexities in the chemical industries which supply them. In World War I America imported most of the nitrates needed in the manufacture of explosives and used the cellulose of cotton and the toluene from coal tar to produce most of the varieties that were used. Today more than eighty per cent of a bomb load is ammonium nitrate. This has necessitated a tremendous expansion of the synthetic ammonia plants of the country. Using hydrogen from water and nitrogen from the air, ammonia is produced under high pressure when passed over suitable catalysts. This ammonia can be oxidized to nitric acid which then reacts with ammonia to give ammonium nitrate, with toluene to give T.N.T., and with cellulose to give nitrocellulose. The demand for these explosives is so much greater than in any previous war that new sources of materials for their manufacture had to be found. Housewives are saving fats so that the supply of glycerine will be ample, woodpulp is being used in addition to cotton for cullulose, and the chemists have learned how to produce large amounts of toluene from petroleum. All of these new additions to the raw material supply require new chemical plants with highly trained personnel. Much of the country is as yet unaware of these demands and draft boards are draining off more and more scientists and technologists into the armed forces. Modern wars cannot be won by having chemists and engineers serve in the armed forces instead of the essential industries where they really are effective producers. The

implements and materials used in this war do not create themselves, nor can soldiers create them on the field of battle. It is high time that Selective Service and the Man Power Commission correct the mistakes that have already been made.

At no time will the shortage of chemists and chemical engineers be so seriously felt as when the synthetic rubber program really gets under way. Synthetic rubbers, several of them, have been made for a number of years in this country but the quantity produced has not been large. Because of the blundering of governmental agencies we started expansion in this field rather late. Had there been vision in Washington there might now be a producing capacity of a half million tons annually and the rubber situation would present a brighter picture. However, the best has been made of a bad start, and chemists and chemical engineers must work at top speed to create and operate this vast new program. By the end of 1943, the rate of production may reach a half million tons.

Stretching Rubber Quota

The ultimate program contemplates the production of more, than 700,000 tons of Buna S, about 130,000 tons of Butyl Rubber 40,000 tons of Neoprene, and more than 30,000 tons of Thiokol. This is on the basis of having available ample raw materials for plant construction and operation, plus the skilled technologists needed to run such complicated processes. It may well be that the real bottleneck in the rubber program will turn out to be an inadequate number of chemists and chemical engineers.

When the Edgewood Arsenal put its 100 tons a day chlorine plant into production in 1918, it was considered a great achievement. It enabled the Chemical Warfare Service to produce large quantities of mustard gas and other poison gases being used at that time. Such production would be relatively small today because more than 700,000 tons of chlorine were produced in 1941, but this was not enough for our needs and it had to be rationed to its industrial users. In a military way chlorine is of the greatest importance because it is absolutely essential in the preparation of all of the important war gases, when and if they are ever used.

In considering the major importance of chemistry in the war effort one must not lose sight of the part this science has played in the field of medicine. Chemists are often compelled to produce materials of destruction, but they also give the world its bene-

ficial drugs and healing agents. The wounded of this war will have a far greater chance to fully recover than ever before. Preventive medicine will eliminate many of the scourges which sapped the strength of the armies of earlier wars. Sanitary water supplies and the proper refrigeration of foods all depend on chemical science for their successful maintenance. Coupled with new knowledge in the fields of nutrition and vitamins it is now possible to feed our armed forces better and also maintain their health at a higher level.

Thus we see that chemistry and chemical engineering occupy indispensable places in our war effort. It has only been possible to sketch some of the more important phases of chemistry's activity. No mention has been made of the remarkable gas masks which our scientists have created and nothing can be said of the secret researches which may have an important bearing on the outcome of the war. Since chemistry deals with all of the materials of the world it touches war activities everywhere. One of the surest ways to lose the war would be to place in the Army any fair percentage of the 70,000 chemists and chemical engineers in the United States. There would soon be little to use in effective combat.

Chemistry Opens the Door

Finally it should be once more emphasized that war accelerates change and in no field is this more true than in science. Chemistry has developed and is developing a vast array of new products which will change the world's style of living far more than it was changed after 1918. Among other things the nation is fighting for the right to use and enjoy these new things. An age of plenty is staring the world in the face once the war is won. Scientists and technologists have the added obligation of seeing to it that the benefits they have helped to bring about are made available to all of mankind.

AIR-COOLED GLOVES TO PROTECT WAR WORKERS

Air-cooled gloves now protect the hands of workers and improve the manufacture of landing lights for airdromes.

It all came about when the head nurse at the Westinghouse Lamp Division here went to the beautiy parlor. If an air blower could be used to cool her head while getting a permanent, she reasoned, why not air cool the gloves used by workers who handle hot glass lamps?

Now a low-pressure air hose extends into the gauntlet of each asbestos glove. This air-conditioning banishes the possibility of burns and workmen can handle the hot lamps with greater speed.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1794. *David Rappaport, Chicago.*

1778. *Proposed by Lucille Rich, Albany, N. Y.*

For equation $x^3+px^2+qx+r=0$, find

$$\sum \frac{a^2}{bc}\left(1+\frac{b}{a}\right)^2\left(1+\frac{c}{a}\right)^2,$$

where a, b, c are roots of the equation.

Solution by A. Struyk, Paterson, N. J.

The root-coefficient relations are $\sum a=-p$, $\sum ab=q$, $abc=r$. Transform the given expression K as follows:

$$K=\sum \frac{a^2}{bc}\cdot\frac{(a+b)^2}{a^2}\cdot\frac{(a+c)^2}{a^2}=\sum\frac{(a^2+\sum ab)^2}{a\cdot abc}=\sum\frac{(a^2+q)^2}{-ar}$$

$$=-\frac{1}{r}\sum\frac{a^4+2a^2q+q^2}{a}=-\frac{1}{r}\left(\sum a^3+2q\sum a+q^2\sum\frac{1}{a}\right).$$

Each $\sum$ in the foregoing result is easily evaluated.

$$\sum a=-p;\qquad \sum\frac{1}{a}=\frac{\sum ab}{abc}=-\frac{q}{r}.$$

By the given equation, $x^3=-px^2-qx-r$. Apply this to each root, and add. Then

$$\sum a^3=-p\sum a^2-q\sum a-3r=-p\sum a^2+pq-3r$$

$$\sum a^2=(\sum a)^2-2\sum ab=p^2-2q$$
$$\sum a^3=-p(p^2-2q)+pq-3r=-p^3+3pq-3r$$
$$K=-\frac{1}{r}\left(-p^3+3pq-3r-p\cdot 2q-\frac{q}{r}\cdot q^2\right)$$
$$K=\frac{p^3}{r}-\frac{pq}{r}+3+\frac{q^3}{r^2}.$$

A solution was also offered by Marcellus M. Dreiling, Collegeville, Ind., in which

$$K=\frac{\sum a^3}{abc}+\frac{\sum a^3b^3}{(abc)^2}+\frac{5}{abc}\sum a^2b+12=\frac{p^3}{r}-\frac{pq}{r}+\frac{q^3}{r^2}+3.$$

1795. *Proposed by Myrtle Hyatt, Newburg, N. Y.*

The sum of two numbers is 5432 and their lowest common multiple is 223020. Find the numbers.

Solution by S. E. Field, Ironwood, Mich.

The highest common factor of 223020 and 5432 is 28.

$$223020=28\cdot 3^2\cdot 5\cdot 59$$

and

$$5432=28\cdot 194.$$

194 must then be the sum of two numbers having as factors one or more of the numbers 27, 5, and 59. These numbers are obviously 135 and 59. Hence the required numbers are $3780=(28\cdot 135)$ and $1652=(28\cdot 59)$.

Solutions were also offered by Malcolm Kirk, West Chester, Pa., and W. R. Smith, Suttons Bay, Mich.

1796. *Proposed by Clinton Burroughs, East Varick, N. Y.*

Prove that a triangle ABC is equilateral if

$$\cot A+\cot B+\cot C=\sqrt{3}.$$

Solution by Aaron Buchman, Buffalo, N. Y.

A, B, C are greater than zero and $A+B+C=180°$.

In the expression, $\cot A+\cot B+\cot C$, let C be constant and let A be the independent variable. Then $F(A)=\cot A+\cot(180°-A-C)+\cot C$ and $F'(A)=-\csc^2 A+\csc^2(180°-A-C)$. Setting $F'(A)=0$, gives the relation,

$$A=\pm n\cdot 180°\pm(180°-A-C) \qquad [n=0, 1, 2, \cdots].$$

Because of the given conditions, however, $F(A)$ is at a minimum only when

$$A=\frac{180°-C}{2}=B.$$

To find the minimum of these minimum values of $F(A)$, let C vary. Then

$$F(C)=\cot\left(\frac{180°-C}{2}\right)+\cot\left(\frac{180°-C}{2}\right)+\cot C$$

and

$$F'(C)=\csc^2\left(\frac{180°-C}{2}\right)-\csc^2 C.$$

Proceeding as above, $F(C)$ is at a minimum only when $C=60°=A=B$. Thus when $A=B=C=60°$, $F(C)=\sqrt{3}$ is a *unique* value of $F(C)$, so that

conversely, when $F(C)=\sqrt{3}$, $A=B=C=60°$ and triangle ABC is equilateral.

Solutions were also offered by Allan Wayne, Flushing, N. Y.; Malcolm Kirk, West Chester, Pa.; W. R. Smith, Suttons Bay, Mich. and Walter R. Warne, Rochester, N. Y.

1797. *Proposed by J. M. Maxey and Paul C. Overstreet, Wilmore, Ky.*

Given:

$$a^2-b^2=c^2-d^2=e^2-f^2 \tag{10}$$

$$a+b+c+d+e+f=3119. \tag{20}$$

Find the positive, integral values of a, b, c, d, e and f which will satisfy the above equations.

Solution by the proposers

Equation (10) can be expressed in the form

$$(a+b)(a-b)=(c+d)(c-d)=(e+f)(e-f). \tag{11}$$

The number 3119 appears to be a prime number. Now, it very often happens that if p, q and r are prime numbers, then the number

$$m=pq+pr+qr \tag{30}$$

is also a prime number. This suggests that we seek three prime numbers, p, q, r, such that

$$pq+pr+qr=3119. \tag{31}$$

For experimental purposes, let us assume that p, q, r do not differ greatly in value, then, by (31)

$$3q^2 \text{ approximates } 3119. \tag{32}$$

From (32) it turns out that

$$q=31.$$

The primes adjacent to 31 are 29 and 37. When these values are inserted in (31) the conditions are satisfied. With p, q, r we are now able to build up the identity

$$pq\cdot mr\equiv pr\cdot mq\equiv qr\cdot mp. \tag{12}$$

When we identify (11) and (12) factor by factor, we find that

$$\begin{aligned} &a=\tfrac{1}{2}(pq+mr), \quad &&b=\tfrac{1}{2}(pq-mr), \quad &&c=\tfrac{1}{2}(pr+mq),\\ &d=\tfrac{1}{2}(pr-mq), \quad &&e=\tfrac{1}{2}(qr+mp), \quad &&f=\tfrac{1}{2}(qr-mp). \end{aligned} \tag{40}$$

Using the values 29, 31 and 37 for p, q and r, respectively, and remembering that pq must be greater than mr in order to avoid negative numbers, we see that m may be any one of the odd numbers, 1, 3, 5, etc., up to and, including 23. Below is a table of values of a, b, c, d, e, f for the different values of m which head the columns:

m	1	3	5	7	9	11	13	15	17	19	21	23
a	468	505	542	579	616	653	690	727	764	801	838	875
b	431	394	357	320	283	246	609	172	135	98	61	24
c	552	583	614	645	676	707	738	769	800	831	862	893
d	521	490	459	428	397	366	335	304	273	242	211	180
e	588	617	646	675	704	733	762	791	820	849	878	907
f	559	530	501	472	443	414	385	356	327	298	269	240

1798. *Proposed by Paul D. Thomas, Durant, Okla.*

The quadrilateral $ABCD$ is inscribed in a circle, but D varies on the circle. A', B', C', D' are the midpoints of semicircles described externally on the sides AB, BC, CD, DA. Find the locus of the intersection of $A'C'$ and $B'D'$.

Solution by the proposer

Let P be the intersection of $A'C'$ and $B'D'$. It is known that for any quadrilateral $A'C'$ and $B'D'$ are orthogonal. Thus angle $A'PB'$ is always a right angle and since the points A' and B' are fixed, the locus of P is an arc of the circle on $A'B'$ as diameter.

1799. *Proposed by George W. Conn, Elm Beach, N. Y.*

When each of two sides of a right triangle is subtracted from the hypotenuse there results 8 and 4. Find the three sides.

First solution by David Rappaport, Chicago, Ill.

Let c = hypotenuse. Then $a=c-8$ and $b=c-4$.

By Pythagorean Theorem, $c^2=a^2+b^2=c^2-16c+64+c^2-8c+16$. Hence,

$$c^2-24c+80=0$$

and

$$c=20$$

$$a=12$$

$$b=16.$$

Second solution by W. R. Smith, Suttons Bay, Mich.

Let a = hypotenuse and θ an acute angle of the triangle. Then $a=a\sin\theta=8$ and $a-a\cos\theta=4$. Hence,

$$2\cos\theta=1+\sin\theta$$

from which

$$a=20$$

$$a\cos\theta=16$$

$$a\sin\theta=12.$$

Solutions were offered also by: Arthur Danzl, Collegeville, Minn.; Walter R. Warne, Rochester, N. Y.; Malcolm Kirk, West Chester, Pa.; A. Struyk, Paterson, N. J.; Daniel Finkel, Mt. Rainier, Md.; Allan Wayne, Flushing, N. Y.; Clyde Yowell, La Plata, Mo.; and the proposer.

1800. *Proposed by Nathan Yoder, Petersburg, Va.*

Show that the roots of $ax^2+2bx+c=0$ are complex if a, b and c are in harmonic progression.

Solution by Aaron Buchman, Buffalo, N. Y.

If a, b, c are in harmonic progression, then

$$b=\frac{2ac}{a+c}. \tag{1}$$

The discriminant of the given equation is

$$4b^2-4ac. \tag{2}$$

Substitute (1) in (2), simplify, and the discriminant becomes

$$\frac{-4ac(a-c)^2}{(a+c)^2}. \tag{3}$$

Thus, if a, b, c are in harmonic progression, and a and c have *like signs*, then (3) is negative and the roots of the given equation are complex.

Note: If a and c have opposite signs, for instance, in the equation, $3x^2-6x-1=0$, the roots are real.

Solutions were offered also by: David Rappaport, Chicago, Ill.; Arthur Danzl, Collegeville, Minn.; Walter R. Warne, Rochester, N. Y.; Addie Yoder, Lexington, Va.; and Nathan Yoder, Lexington, Va.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editors Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below:

1799. Louis Boness, Chicago, James Smith, Lake City, Mich.

SOLUTION OF PROBLEMS

1813. *Proposed by Anna McGreegen, Marcellus, N. Y.*

If n is an odd integer and not divisible by 3, prove that n^2+5 is divisible by 6.

1814. *Proposed by Leona Henry, Valley Forge, Pa.*

If A, B, C, D be four consecutive vertices of a regular heptagon inscribed in a circle of radius unity, show that $AC+AD-AB=\sqrt{7}$.

1815. *Proposed by Paul C. Overstreet, Wilmore, Ky.*

Water is flowing into a vertical cylindrical tank at the rate of 100 gallons per minute and is flowing out through a one square inch opening in the bottom of the tank. If the area of the cross section of the tank is one square foot, how long will it be before the water in the tank reaches a permanent level?

1816. *Proposed by Julius Brandstatter, Los Angeles, Calif.*

Find a triangle with integral sides and area, such that the distances from A, B and C to the center of the inscribed circle shall be integers.

1817. *Proposed by Don Marshall, Dearborn, Mich.*

In scalene triangle ABC, $AC=3$ in., the altitude from B is 5 in. and angle $B=18°$. Find length of AB.

1818. *Proposed by Hugo Brandt, Chicago.*

a. In an acute angled triangle, with base b and altitude h, inscribe a square with side s whose base is colinear with the triangle's base, while the other two corners lie on the triangle's other two sides.

b. Find an expression for s in term of b and h.

c. With the triangle of problem (a) as base erect a pyramid (tetrahedron) of altitude a, in which inscribe a cube of side s_1 whose base is coplanar with the triangle and whose top face is inscribed, as in (a), in the smaller triangle that forms the intersection of its place with the pyramid.

Find an expression for s_1 in terms of b, h and a.

SCIENCE QUESTIONS

March, 1943

Conducted by Franklin T. Jones
10109 Wilbur Avenue, S.E., Cleveland, Ohio

Contributions are desired from teachers, pupils, classes and general readers. Send examination papers from any source whatsoever.

It is natural that questions connected with the War Effort will be especially appreciated.

Questions on any part of the field of science; questions having to do with the pedagogy of science; new applications of old ideas; present variations of perhaps ancient questions; anything that appeals to the reader, or might appeal to other readers—all are wanted.

What interests you, will most likely, interest others also.

We will endeavor to obtain answers to all reasonable questions. It is always valuable to get questions whether we can get the answers or not.

Contributors to SCIENCE QUESTIONS are accepted into the GQRA (Guild of Question Raisers and Answerers).

Classes and teachers are invited to join with others in this cooperative venture in science.

SCRAPBOOK PICTURES OF GQRA MEMBERS

It has been suggested to the Editor that a book of pictures of members of the GQRA should be prepared. It is true that many of the contributors to SCIENCE QUESTIONS are and have been leaders in Science and Mathematics affairs.

Please send in your picture—snapshot or otherwise.

HOW GOOD A SCIENTIST ARE YOU?

993. *A Test from "Research Progress," June, 1942, of Westinghouse Research Laboratories.*

Here is a test that probably shows nothing about your scientific ability. It may show something about how closely you read the current news of science, and how well you remember it. At any rate, it you get more than 8 right you shouldn't be wasting your time with quizzes—you're a genius. If you get 6 out of 10, you are better than most; and if your score is less than 5—well, it's all in fun anyway. The idea is to pick the answer you believe comes closest to the truth. The answers are at the bottom of this text.

1. In a cubic centimeter of air the number of molecules is about (A) 10,000; (B) 10 quintillion; (C) 10 million.
2. Grenz rays are (A) bactericidal ultraviolet radiations; (B) long-wave X rays; (C) cosmic rays.
3. Astronomers recently discovered that the sun is (A) 1 million; (B) 750,000; (C) 100,000 miles farther from the earth than they previously thought.
4. A virus is (A) a vaccinate for hog cholera; (B) a disease-producing organic molecule; (C) a new kind of vitamin that promotes growth.
5. Sulfathiazol is (A) a medicine; (B) a poison gas; (C) a photographic developer.
6. Neutrinos are (A) natives of the prehistoric island of Neutrin, (B) hypothetical subatomic particles; (C) medicines that neutralize excessive body acid.

7. If you had a piece of string 1 astronomical unit long, it would be (A) 1,000 miles; (B) 1 meter; (C) 93 million miles long.
8. The universal standard of length is (A) the meter; (B) the light year; (C) the wave length of the spectral emission of cadmium.
9. A 1,000-pound aerial bomb falls approximately (A) 10 times; (B) same speed; (C) 16.1 times as fast as a 100-pound bomb.
10. Velocity of light is (A) same; (B) 20 times; (C) 200 times that of sound.

Answers to 993

Please cover until you have selected your answers; then compare.
1B; 2B; 3C; 4B; 5A; 6B; 7C; 8C; 9B; 10C.

WORK FOR NON-BOOK-MINDED PUPILS

994. *Proposed by Miss Lillian A. MacDonald (GQRA, No. 327), South Side High School, Newark, N. J.*

"At present my chief problem is to find suitable work for non-book-minded pupils who are scheduled for a non-mathematical physics course.

"We have used simplified laboratory work and motion pictures with very satisfactory results.

"Is this problem peculiar to the East?

"I should be glad to know what other schools are doing along this line."

FIRE PROTECTION

995. *What are you doing about fire protection?*

(1)—Have you a fire protection check list chart?

Answer—One was published some time ago in *School Management*. A copy can be obtained by writing to Safety Research Institute, 420 Lexington Avenue, New York, N. Y.

(2)—How and how often should fire extinguishers be re-charged?

Answer—"The Underwriters Laboratories recommend that only recharges supplied by manufacturers of approved extinguishers be used. Substitutes are dangerous . . . ."

An advertisement printed in *Best's Insurance News* for Walter Kidde & Company, Inc., 1046 West Street, Bloomfield, N. J. Tells about—

"FIRE and how to fight it." Write for the series of advertisements direct to Walter Kidde, Inc.

(3)—Practice in using fire extinguishers.

Answers—Since you must empty the extinguisher in order to recharge it, take this opportunity to give custodian, teachers, and older pupils a chance to practice the use of an extinguisher. You can undoubtedly get police permission to burn some rubbish and put it out with the extinguisher. Consult your nearest Fire Dept. station.

(4)—*Problem*—What would you have done?

A technical graduate who was serving as an assistant foreman in a machine shop was called by a workman whose electric motor was blazing. The foreman grabbed the nearest extinguisher and directed the stream against the smoking motor. He was promptly kicked across the shop. Why? What should he have done?

DAYLIGHT ROBBERY

995. Should Ohio and Michigan continue on Eastern War Time or on Central War Time? Which is just the same as saying should Ohio, at least, go back to its old "daylight saving time" (the same as Eastern Standard Time) instead of continuing to use Eastern War Time?

Discussion based upon articles in The Cleveland Press, and The Cleveland Plain Dealer.

The Legislatures of Ohio and Michigan have been considering the introduction of bills to shift these states from the Eastern War Time zone to the Central War Time zone. In Michigan at this date (Jan. 31, 1943) the subject is quiescent because of an opinion by the Attorney-General of Michigan that the Legislature does not have power to make the change. In Ohio Attorney-General Herbert is of the opinion that Ohio can adopt time for its own state but the power to decide upon Railroad Time and Federal Time is beyond its powers. Any change in official Ohio time would then result in Ohio's having two kinds of time—Eastern War Time and Eastern Standard Time.

A Few Questions:

(1)—Does the use of E.W.T. increase or have a beneficial effect upon production? (If so, all are agreed that it should be continued.)
(2)—Does the use of E.W.T. cause a saving of electricity?
(3)—What are its effects upon the home, the school, and other institutions?

Some Answers:

Donald Nelson thinks that E.W.T. does have a beneficial result upon industrial production. He has, as far as known, not expressed himself upon farm production. He says that its use has resulted in the saving of electricity. The officials of the War Production Board in Washington say that they have no figures to show that E.W.T. has saved power consumption in Ohio. Reports from Ohio power companies indicate that the savings, if any, have been negligible.

Schools in Ohio have been so inconvenienced that, in many instances, hours of opening schools have been made later. A school opening sessions, at 8:15 A.M., E.W.T., would open before the sun was above the horizon from about November 12 to February 12.

Professor Elbert H. Clarke (Mathematics and Astronomy), Hiram College, Hiram Ohio, said, in a letter to the *Plain Dealer* on January 1, 1943:

"The sun came up in Hiram this morning at 10 minutes before 9 o'clock . . . . There is no sound argument for keeping Ohio in the dark all winter . . . . At the end of June sunset will come to Cleveland at 5 minutes past 10 and to Toledo at 12 minutes past 10. It will be terribly hot at bedtime . . . . What daylight we steal from one end of the day is stolen back from us at the other . . . ."

Dr. J. J. Nassau, Professor of Astronomy at Case School of Applied Science, GQRA, No. 339, prepared an "hour-glass of night and daylight" showing hours of sunset, end of twilight, beginning of dawn and sunrise, which was published in *The Cleveland Press* of January 22, 1943. It shows that, at about the time you receive this copy of the JOURNAL (if it is March 19), the sun would set about 7:40 E.W.T. and rise about 7:35 E.W.T. Dr. Nassau points out these facts from his chart:—

(1)—If you are in the habit of rising at 7:00 A.M., E.W.T., you must get up before sunrise from January 1 to April 9, and from August 30 to December 31—more than seven months of the year.

(2)—If you are in the habit of eating dinner at 6:00 P.M., you will be eating before sunset on every night of the year.

(3)—If it is your custom to go to bed at 10:00 P.M., you will be going to bed before the end of twilight from June 5 to July 26, a period during which it is frequently insufferably hot until quite some time after sunset.

(4)—If your child goes to bed at 6:00 P.M., E.W.T., he will go to bed before sunset on every night of the year.

Mr. Raymond T. Kelsey, Editor of *The Ohio Farmer* said:

"Undoubtedly the present time system creates hardships for the farmers. . . . Under the present system farmers have to get up an hour earlier, but they can't make hay or combine wheat if there is still dew on it . . . ."

Ed Bath of the Ohio Farm Bureau Federation described the sad plight of the dairymen in E.W.T.:

"Farm animals have regular habits and they don't know anything about war time. The farmer has to go to the barn when it is still dark in the morning; but the old cow won't let her milk down until she is ready and she doesn't want to get up before daylight . . . . So the farmer has to turn on the electric lights that he is supposed to be saving, and kick the cow in the belly to make her get up . . . . That's an unnatural procedure, and she won't let her milk down until she's good and ready."

Consider the sad plight of the inhabitant of Ohio in these days of Eastern War Time.

Make yourself an "hourglass of times" and see just what it means to you in your own part of the time-belt in which you are located. (Probably *The Press* would send you a copy of the *Stocks Edition* for January 22, 1943, with this chart in it, for a nickel. It is first page news.)

GOOD SHOOTING

996. Navy guns 26 miles away aimed by radio direction smashed the *Jean Bart*, French warship, on the second salvo in the recent action in North Africa. (News Item.)

Who can tell how it was done?

TRAMP IRON DETECTOR

997. Andrews and Petrillo, Inc., have designed a device for detecting commercially even a tack in scrap rubber which passes through it on a conveyor belt. (*Electronic Industries*, November, 1942.)

Who knows how it works?

SCIENTIFIC NEWS ITEMS

998. (1)—Westinghouse electroplates three cans with the tin that formerly would dip only one can. (Adv't *Collier's*, Jan. 23, 1943, page 49.)

(2)—Industrial Alcohol—*Life*, December 28, 1942, pages 54–7.

Raw Materials—Wheat, about 32%; barley, about 8%; corn, 60%.

Into the smokeless powder of the charge for one 16-inch shell goes a half-acre's crop of corn.

War needs for industrial alcohol in 1943, 500,000,000 gallons.

A whiskey plant has recently been converted almost 100% to industrial alcohol.

(3)—Kodak's aerial lenses, made with rare-element glass (tantalum, tungsten, lanthanum)—"First Basic Discovery in 55 years") makes possible an f/2.5 lens. (*Sat. Ev. Post*, Jan. 9, 1943, page 33.)

SYNTHETIC RUBBER

978. *Hit and Miss Facts about Synthetic Rubber.*

(1)—Goodyear's synthetic is advertised as CHEMIGUM; Goodrich's as AMERIPOL.

(2)—Firestone advertises that they "discovered Butaprene."

Write to each of these companies and ask for any descriptive material about their synthetics. Use the above names. Look for advertisements in current magazines, especially in the *Saturday Evening Post, National Petroleum News*, and *Collier's*.

(3)—National Fire Protection Association, 60 Batterymarch St., Boston, Mass. has for sale a booklet entitled *Synthetic Rubber*, price 20 cents.

(4)—Standard Oil Co. of Ohio is erecting a plant for "cracking" gasoline that will cost Standard $7,000,000. The company is financing the plant without government aid. It will be used to make 90-octane gasoline, the base stock for synthetic rubber. (January 28, 1943.)

(5)—Jeffers, Rubber Administrator, gets "GO" for 452,000 tons of synthetic. All but 17,000 tons will be for BUNA-S, the type needed for military and civilian transport. The 43.6% granted is in terms of plant facilities which can turn out ready-to-use rubber.

(6)—It is reported that no synthetic has yet been turned out by a government plant. However, the great rubber companies, chemical companies and oil companies are turning out the amounts, approximately, that they estimated for 1942 and 1943.

Send in your Questions, Answers, Comments

JOIN THE GQRA!

VICTORY SHIP NAMED FOR DESIGNER OF GIANT TELESCOPES

A noted American astronomer, designer of the 100-inch telescope at the Mt. Wilson observatory and projector of the huge 200-inch reflector now being built for the new observatory on Mt. Palomar, was commemorated in the launching of the Victory ship George E. Hale, just off the ways of the California Shipbuilding Corporation here. Dr. Hale's widow, Mrs. George E. Hale of Pasadena, was sponsor of the new vessel, which is the 125th to be built by the company in the present war program.

Dr. Hale died at Pasadena in 1938, at the age of 70 years. Besides planning the most massive instruments ever built for the exploration of the heavens, he carried on researches in solar physics and stellar evolution, and was one inventor of the spectroheliograph, which makes photographs of the sun in the light of a single selected element. He shares the latter honor with a French astronomer, Deslandres.

BOOKS AND PAMPHLETS RECEIVED

FUNDAMENTAL JOBS IN ELECTRICITY, by Edgar C. Perry, A.M., *Superintendent of Schools and Director of Defense Training Classes, Indiana, Pennsylvania;* Harry V. Schafebook, *Instructor in Electricity, John B. Stetson Junior High School,* Philadelphia, Pennsylvania. Cloth. Pages xiv + 447. 14.5×23 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.20.

ELECTRIC WIRING, A TEXTBOOK OF APPLIED ELECTRICITY FOR VOCATIONAL AND TRADE SCHOOLS, by Albert A. Schuhler, *Electrical Engineer, Member American Institute of Electrical Engineers.* Fourth Edition. Cloth. Pages ix+400. 12.5×19 cm. 1943. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.50.

CHEMICAL-TECHNICAL DICTIONARY (GERMAN-ENGLISH-FRENCH-RUSSIAN), by A. W. Mayer. Translation under the Direction of Professor B. N. Menshutkin and Professor M. A. Bloch. Cloth. 872 pages. 13.5×21.5 cm. 1942. The Chemical Publishing Company, Inc., 234 King Street, Brooklyn, N. Y. Price $8.00.

COMMON EDIBLE MUSHROOMS, by Clyde M. Christensen, *Assistant Professor of Plant Pathology, University of Minnesota.* Cloth. Pages x+124. 13.5×20.5 cm. 1943. The University of Minnesota Press, Minneapolis, Minn. Price $2.50.

A FIRST COURSE IN ALGEBRA, by Virgil S. Mallory, *Professor of Mathematics and Instructor in the College High School, State Teachers College, Montclair, New Jersey.* New Edition. Cloth. Pages vii+510. 12.5×18.5 cm. 1943. Benj. H. Sanborn and Company, 221 E. 20th Street, Chicago, Ill. Price $1.48.

A SOURCE BOOK OF MATHEMATICAL APPLICATIONS COMPILED BY A COMMITTEE ON THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS, by Edwin G. Olds, *Carnegie Institute of Technology, Chairman:* Lee E. Boyer, *Millersville State Teachers College;* Ruth O. Lane, *State University of Iowa;* Nathan Lazar, *Bronx High School of Science;* and F. Lynnwood Wren, *George Peabody College for Teachers.* Seventeenth Yearbook. Cloth. Pages xvi+291. 14.5×23 cm. 1942. Bureau of Publications, Teachers College, Columbia University, 525 W. 120th Street, New York, N. Y.

ELECTRICITY FOR EVERYONE, by Joseph R. Lunt, *Late Professor of Science at Rhode Island College of Education,* and William T. Wyman, *Practical Electrician, Chairman of Electrical Department, Central High School, Providence, Rhode Island.* Cloth. Pages x+649. 13.5×21.5 cm. 1943. Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.56.

SOLID GEOMETRY, by A. M. Welchons and W. R. Krickenberger, *The Arsenal Technical High School, Indianapolis, Indiana.* Revised Edition. Cloth. Pages vii+276. 13×19.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $1.48.

BEFORE YOU FLY, ESSENTIALS OF AERONAUTICS, by Pearle Thurber Robinson, M.A. *Teacher of Preflight Aeronautics, George Washington University, Washington, D. C.;* Frederic A. Middleton, B.A., *Teacher of Preflight Aeronautics, Washington High Schools, Washington, D. C.;* George M. Rawlins, Jr., Ph.D., *Head of the Department of Science in the Washington Elementary and Junior and Senior High Schools, Washington, D. C.;* and

Joseph W. Phillips, Ph.D., *Major, United States Army*. Cloth. Pages xvi+568+lvi. 13.5×21 cm. 1943. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $2.00.

POPULAR MATHEMATICS, by Denning Miller. Cloth. Pages xi+616. 13.5×21.5 cm. 1942. Coward-McCann, Inc., 2 West 45th Street, New York, N. Y. Price $3.75.

MAN'S PHYSICAL UNIVERSE, by Arthur Talbot Bawden, *President of the Stockton Junior College, Stockton, California*. Revised Edition. Cloth. Pages xv+832. 15×23.5 cm. 1943. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.00.

FUNDAMENTALS OF MACHINES, by Burton L. Cushing, *Head of the Department of Science, East Boston High School, and Lecturer on the Teaching of Physics at the Harvard Graduate School of Education*. Cloth. Pages x+436. 13.5×20 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $1.24.

FUNDAMENTALS OF ELECTRICITY, by Lester R. Williard, *Thomas Jefferson High School, Elizabeth, New Jersey*. Cloth. Pages vi+351. 13.5×20 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $1.24.

WARTIME REFRESHER IN FUNDAMENTAL MATHEMATICS, by Lieutenant W. C. Eddy, U.S.N. (Ret.); A. H. Brolly, *Chief Instructor;* Ensign E. S. Pulliam, U.S.N.R.; E. C. Upton; G. W. Thomas, *U. S. Naval Training School, Chicago*. Cloth. Pages viii+248. 12×18.5 cm. 1942. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $1.40; Text Edition $1.05.

ODD NUMBERS, OR ARITHMETIC REVISITED, by Herbert McKay. Cloth. 215 pages. 12.5×19 cm. 1943. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $2.00.

FUNDAMENTALS OF ELECTRICITY, A PRE-INDUCTION COURSE, by Fred R. Miller, *Author of Progressive Problems in Physics*. Cloth. Pages vii+220. 14×20 cm. 1943. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.00.

EVERYDAY SCIENCE, by Otis W. Caldwell, *Professor Emeritus, Teachers College, Columbia University and General Secretary of the American Association for the Advancement of Science*, and Francis D. Curtis, *Head of the Department of Science, University High School and Professor of the Teaching of Science, University of Michigan*. Cloth. Pages xiii+664. 15.5×23.5 cm. 1943. Ginn and Company, Statler Building, Boston, Mass. Price $1.96.

THE PRACTICAL OUTLINE OF MECHANICAL TRADES FOR HOME STUDY. Edited by William L. Schaaf, Ph.D., *Assistant Professor of Education, Brooklyn College, and Assisted by a staff of Technical Specialists and Authorities*. Cloth. Pages xix+594. 13×21 cm. 1942. Garden City Publishing Company, 14 West 49th Street, New York, N. Y. Price $3.95.

HANDBOOK OF MICROSCOPIC CHARACTERISTICS OF TISSUES AND ORGANS, by Karl A. Stiles, M.S., Ph.D., *Bert H. Bailey Professor of Biology and Chairman of the Division of Natural Science, Coe College*. Second Edition. Paper. Pages xi+204. 14.5×23 cm. 1943. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $1.50.

GENERAL PHYSICS FOR THE LABORATORY, by Lloyd W. Taylor, *Professor of Physics, Oberlin College;* William W. Watson, *Professor of Physics, Yale University;* and Carl E. Howe, *Assistant Professor of Physics, Oberlin*

College. Revised Edition. Pages vii+184+107. Paper. 18.5×27.5 cm. 1942. Ginn and Company, Statler Building, Boston, Mass. Price $2.00.

SPHERICAL TTIGONOMETRY WITH TABLES, by W. C. Brenke, *University of Nebraska. Paper.* Pages viii+71+27. 13.5×20.5 cm. 1943. The Dryden Press, Inc., 103 Park Avenue, New York, N. Y. Price 80 cents.

THE USE OF TEST RESULTS IN DIAGNOSIS AND INSTRUCTION IN THE TOOL SUBJECTS, by Arthur E. Traxler. Educational Records Bulletin, No. 18 (Revised). Pages vii+80. 21.5×27.5 cm. December, 1942. Educational Records Bureau, 437 West 59th Street, New York, N. Y.

BOOK REVIEWS

PRINCIPLES OF RADIO, by Keith Henney, *Editor, Electronics Author, Electron Tubes in Industry, Editor, Radio Engineering Handbook, Member, Institution of Radio Engineers.* Fourth Edition. Cloth. Pages xii+549. 13×19.5 cm. 1942. John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y. Price $3.50.

This is the fourth edition of a book written for beginning students—whose who know practically nothing about radio and very little about electricity. In the Preface it is pointed out that "this, the Fourth Edition, has been brought up to date, . . . " But on the first page it is stated that "the elements are composed of negative electrical charges known as electrons, and positive charges known as protons." In the next paragraph we find "if a body has an excess of either negative or positive electricity it is said to be charged." Many similar questionable or faulty statements can be found showing that the revision has failed to eliminate errors that are now quite obvious. It is really too bad that a book of so many excellent qualities has not been corrected in these minor details.

The general features of the book have not been changed by the new edition but many improvements have been added. The author first gives a practical discussion of electrical principles covering the fundamental ideas of electromotive force, resistance and current intensity, electric meters and their use, batteries and their care and limitation, and the fundamentals of D.C. generators. Then follow chapters on inductance, capacitance, A.C. circuits, resonance, coils and condensers. Throughout this entire preliminary discussion many problems are interwoven, practically all dealing with radio circuits. The remainder of the book is devoted to the fundamentals of radio apparatus and theory and gives a fairly complete elementary treatment of the subject. The last chapter gives a brief discussion of television. It is a book well suited for its original design, covers the fundamentals of radio quite thoroughly, and without the use of any mathematics but arithmetic, algebra and a little trigonometry. The many suggestions for laboratory work give a good basis for the necessary experimental training needed for an understanding of the theory discussed.

G. W. W.

ELEMENTARY MATHEMATICS IN ARTILLERY FIRE, by Joseph Miller Thomas, *Professor of Mathematics, Duke University* with Tables prepared by Vincent Haag. Cloth. Pages xi+255. 16×23.5 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.50.

This book presupposes elementary algebra, plane geometry, and plane

trigonometry. It is intended as a text for a course of one-half year. There are twelve chapters with headings as follows:

Angles, Tables, Some Geometric Theorems, Model Solutions of Triangles, Maps, Location, Parallax, Difference in Level, Trajectory in Vacuo, Range Tables, Probability, and Adjustment Fire.

The exposition is phrased in the language of Higher Mathematics.

J. M. KINNEY

THE SEASHORE PARADE, by Muriel Lewin Guberlet. Illustrations by Jan Ogden. 200 pages; more than 80 illustrations, some in color. Jaques Cattell Press, Lancaster, Pa. Price $1.75.

This is a popular science book written so that children can understand it, but one which older people will enjoy reading. It is an introduction to knowledge of the forms of life that inhabit the beach stretches between high tide and low tide. It will be of more interest to persons living near the sea shore and to others whose travels may take them to the sea where they can observe the animals alive and active in their native habitat. However, the book offers interesting and enlightening information which will lead to a better understanding of these forms and of animal life in general by persons to whom the beach is not accessible. The language and forms are admirably suited to secure and holding the interests of children. The facts are presented from a nature study point of view. Older readers will have no difficulty in arriving at an understanding of the microcosm which this habitat presents. The author is to be complimented in embodying so much material in so delightfully interesting form.

JEROME ISENBARGER

MICE, MEN AND ELEPHANTS, by Herbert Zim, *New York City Schools*. 215 pages, 47 photographs and 33 drawings. Harcourt, Brace and Company, New York.

This should be a welcome addition to the growing list of recent popular books on science. The book seems best suited for supplementary reading for children of the junior high school ages. However, older persons will enjoy it for the science and for the method of presentation. The reader is led to a better understanding of ourselves as mammals through the study of the group as a whole. In disregard of the natural interest that children have in the mammals of the zoo, in pets in the home and in blooded stock and other animals of the farm, the schools have failed to utilize to the fullest extent this approach to the problem of answering the questions that children ask about themselves. Questions regarding mammal characteristics, response to stimuli, coordination, mating, rearing of young, and mammal relationships are treated in their natural order and in straightforward language in such a way as to make the answers readily comprehensive.

JEROME ISENBARGER

OUTLINES OF ECONOMIC ZOOLOGY, by Albert M. Reese, *Professor of Zoology, West Virginia University*. Fourth Edition. Cloth. Pages xii+359. 14×21 cm. 1942. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $3.25.

The author of this book has assembled an unusual body of interesting information on the economic importance of animals. The vertebrates receive considerably more than half the space. There are special chapters on Protozoa, Porifera, Coelenterata, Echinodermata, Platyhelminthes, Nemathelminthes, Annulata, Mollusca, and Arthropoda. Each chapter

opens with a brief description and classification of the particular group. This is followed by descriptions of examples having economic importance, including both beneficial and harmful species. Conservation is given due attention.

A wide variety of sources, including Government publications and special books and articles, has been drawn upon; and a classified list of references, consisting of 348 titles, is appended. Citations to references are made by number in the body of the text. Numerous drawings and halftones add much to the effectiveness of the work. There is a very thorough index. The book should prove valuable as a text for courses in economic zoology and as collateral reading for students in general biology and zoology.

EDWARD C. COLIN
Chicago Teachers College

BASIC MATHEMATICS, A SURVEY COURSE, by Walter W. Hart, *Author of Mathematics Texts*. Cloth. Pages vi+456. 20×14.5 cm. D. C. Heath and Company, Boston, Mass. Price $1.52.

This text is most certainly a survey course, in fact it is almost an elementary reference book. It has been planned to provide the training in mathematics needed in the present emergency. Because of the condensed explanations, in many parts a good teacher will be needed. The book is divided into two parts, the general content of which is indicated by chapter headings: Part I—Arithmetic Computation, Elementary Geometry, Mensuration of Figures, Elementary Algebra; Part II—Logarithms, Elementary Trigonometry, Demonstrative Geometry, Solid Geometry, Advanced Algebra. The problem material utilizes much material from the airplane industry, such concepts as longitude and latitude, graphic solutions of problems in aeronautics, scale drawings and blueprints.

From the point of view of one who has been teaching pilot trainees in the CAA War Training Service, one can only wish that more students had studied a text like this in high school. The scope of material covered is not adequately given by the chapter headings, a few subjects selected at random will help visualize the completeness of the book for the purpose planned: angles in aeronautics, wind-drift problems, the earth as a sphere, longitude and time, pulleys and gears, the slide rule, spherical triangles, Lambert charts, addition of integers and decimals, common fractions, compound interest problems.

There seems to be an ample supply of problems. Numerical tables include squares, cubes, square roots, cube roots, four place logarithms, and four place natural values as well as logarithmic values of the trigonometric functions. No answers to problems are given in the text.

CECIL B. READ
University of Wichita

A FIRST COURSE IN MATHEMATICS FOR STUDENTS OF ENGINEERING AND THE PHYSICAL SCIENCES by Edward Baker, *Newark College of Engineering*. Cloth. Pages xiii+295. 23.5×16 cm. D. Van Nostrand Company, Inc., 250 Fourth Ave., New York, N. Y. Price $3.00.

The material covered includes algebra, trigonometry, plane and solid analytic geometry, and some elementary calculus. The approach is quite definitely from the engineering viewpoint. This is emphasized particularly in the problem material; another example is the treatment of the solution of the oblique triangle when three sides are given: with the statement, "problems falling under this case are comparatively rare in technical work," the author devotes about one-half page to the solution and gives three examples for the student to work.

A feature which strikes one at first is the introduction of many concepts by use of vectors. For example, the cosine of an angle is essentially defined as a multiplying factor, which, when applied to a vector, gives its component in a certain direction. Other trigonometric functions are likewise defined.

In some portions of the book there seems to be an ample supply of problems, in others, as for example in polar coordinates, the number seems hardly adequate. Answers accompany some of the problems, the number of problems for which answers are furnished varies from less than ten per cent in some sets to over half in others.

If a teacher wishes a text with rigorous definitions of the terms used, he will not be completely satisfied with this book; for example, the terms radian, logarithm, asymptote have no formal definition. In fact, one cannot find *asymptote* in the index although the asymptotes of the hyperbola are discussed on page 208.

Inside the front and back covers one finds a summary of formulas from Geometry, Algebra, Trigonometry, and Analytic Geometry. There are no tables of logarithms, squares, or similar numerical tables.

CECIL B. READ
University of Wichita

PRINCIPLES OF COLLEGE ALGEBRA, by Morris S. Knebelman, *Head of the Department of Mathematics, The State College of Washington*, and Tracy Y. Thomas, *Professor of Mathematics, University of California at Los Angeles*. Cloth. Pages x+380. 22.5×16 cm. Prentice Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $2.50.

Personal acquaintance with both authors during his graduate work at Princeton has made the reviewer examine this book with more than the usual interest. The treatment differs markedly from the usual text. The authors have endeavored to appeal to the student's reasoning power, emphasizing an understanding and appreciation of the fundamental nature of algebra rather than developing facility in the manipulation of algebraic symbols. As evidence of a degree of rigor not always found in introductory college algebra texts one might emphasize the continued emphasis upon the care which must be taken in proofs to exclude division by zero; the definition of a fractional exponent and of a mantissa; the statement and proof of the conditions under which a linear equation of the first degree in two variables has a graph which is a straight line.

The text covers in more detail than is customary such topics as coordinates in space, linear dependence, matrices, undetermined coefficients, prime numbers. The authors have intentionally emphasized the algebraic rather than the functional viewpoint. Although the authors point out that they have purposely excluded "story" problems, there seems an ample supply of problems, with answers to about half given in the back of the text. Cumulative exercises at the end of the chapters are largely taken from recent examinations given at various colleges and universities—the source is stated. In addition, at the end of the book are found ten complete final examinations.

This book is not intended for a survey course. In many cases it would no doubt be a marked change from the text now in use; it might not be a feasible text for students with a minimum of secondary school preparation; the prospective engineer might object from the point of view that there are no problems immediately obvious as practical engineering applications. Nevertheless, one might well consider the question: is this not the type of text we *should* be using? If for no other reason, a copy should be available

for reference to the type of question being used in other schools.

The book has a pleasing appearance, only one slight typographical error was noted (page 128). Aside from a four place table of logarithms, there are no numerical tables.

CECIL B. READ
University of Wichita

SCIENCE IN MODERN LIFE SERIES, by Victor C. Smith, *Department of Science, Ramsey Junior High School, Minneapolis, Minnesota;* and Gilbert Trafton, *Department of Biology, State Teachers College, Mankato, Minnesota*, in Consultation with W. R. Teeters, *Supervisor Physical and Biological Sciences, St. Louis Public Schools, St.Louis, Missouri.* J. B. Lippincott Company, 333 West Lake Street, Chicago, Illinois. Exploring Science, Book 1. Cloth. Pages xii+458. 13.5×21 cm. Price $1.32. Enjoying Science, Book 2. Cloth. Pages xii+596. 13.5×21 cm. Price $1.52. Using Science, Book 3. Cloth. Pages xii +802. 13.5×21 cm. Price $1.80.

The series Science in Modern Life is planned for upper and junior high school grades. A grade designation does not appear in the book but dots on the cover indicate which of the series it is. Because of this, the books may be better grade placed by the user than other books which carry a definite grade classification.

The number of pages seems rather high but the 299 illustrations in Book 1, 379 illustrations in Book 2, 558 illustrations in Book 3, take up a large amount of space even though most of the photographs are bleeds. The pictures are excellent, being very well chosen for the text material and the captions result in thinking because they raise questions. Much knowledge is gained from the pictures alone.

The structure of the material in the entire series is of the usual type of large units subdivided into problems. At the end of each problem there is a test which checks the accuracy of study of the problem. This is followed by a list of activities pertaining to the problem. At the end of each unit there is a short review in composition form. Exercises in thinking which are composed of several types of tests and general questions, short list of books of a popular nature relating to the unit, and a very unusual feature which will be followed in newer books of visual aid material. This material suggested consists of film strips and slides at the end of the problems with movies and slides at the end of the unit. The visual aid material suggested is of the type that can be obtained by rental, purchase, or transportation charges. This feature makes the teacher aware of materials available outside of those visual aids developed in the classroom.

Another important feature of the series is the real effort to help the student with the new words. You know from the Curtis study that the general science vocabulary is most difficult because it contains 1564 new words or more than any other high school science. Most of the new words are defined and pronunciation shown by diacritical marks.

In just glancing through the books one might classify the series as a "reader," but upon reading the books you are impressed with the experiments. They are given very clearly and instead of the formal writing up of experiments the teacher can have the pupils answer the questions under, "What was observed" and "What was learned" making for simpler, more meaningful written reports.

Content is always an important factor in choosing a textbook. This series fits more closely the general information pupils desire than earlier books. Only rarely do the books go into too great detail for the average general science pupil. In reading the series you see a definite effort on the

part of the authors not to crowd it with technical terms, but occasionally they have aroused curiosity as in the topic "What are the different types of clouds?" and the names or descriptions are not given as in Book 1. The books are definitely away from the specialized science approach. Very lttle material is questionable and those depend on teacher interpretatiion and source material. The content is right up to date, as much consumer information is given. We find Dreft and homogenizers mentioned. The health content is of the variety that is meaningful to the child but a page tally of a forty page unit will not correspond with the older books. Without a tallied study of the subject matter, the series seems, by far, a more balanced treatment of content material than any of the older series. It would be interesting to take time to classify material as Cureton did in *Science Education* 1929 or Pettit in this journal in 1940 or Hunter and Parker in this journal in 1942. Experience of the authors as textbook writers is readily detected in the organization of subject matter content. The errors evident in earlier series seems to be corrected so that pupils having studied any one or all of the books will have a better understanding of things around him. Teachers considering new books should acquaint themselves with this series.

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A COURSE OF INSTRUCTION IN THE QUALITATIVE CHEMICAL ANALYSIS OF INORGANIC SUBSTANCES. Arthur A. Noyes, late *Professor of Chemistry, California Institute of Technology*. Tenth Edition, Revised and Rewritten by Ernest H. Swift, *Associate Professor of Analytical Chemistry, California Institute of Technology*, The Macmillan Company, New York, N. Y., 1942. xv+418 pp. 13 figs. 14×21.5 cm. $2.75.

This well known text by A. A. Noyes appears in its tenth edition revised and rewritten by E. H. Swift. That the fundamental objectives remain the same is emphasized by having the introductory paragraph to the preface of the eighth (1920) edition serve to introduce the tenth. The aims are set forth as follows: "This text-book is an attempt, on the experimental side, to train the student of qualitative analysis in careful manipulation and exact methods of procedure, such as are commonly employed in quantitative analysis. It is an attempt on the theoretical side, to make clear to the student the reason for each operation and result, and to accustom him to apply to them the laws of chemical equilibrium, and especially the principles relating to solubility and to the ionization, complex-formation, and oxidation and reduction of substances in solution."

The plan of the book is essentially unchanged, with a division into two main parts entitled "The Course of Instruction," and "The System of Analysis." The first part includes two sections, one devoted to laboratory experiments giving directions for the laboratory work; and the second consists of a series of questions on the experiments. The second part covers in detail the procedures for the analysis for basic and acidic constituents, and includes a detailed discussion of the preparation of a solution of the sample for analysis. A number of minor changes have been made in the metal analysis, particularly with regard to the analysis of the Tin Sub-Group. The analysis for the acidic constituents has been revised and extended. A commendable major change from the older editions is the insertion immediately before the procedures of a brief discussion of the fundamentals and principles involved. Disadvantages inherent in such a segmented presentation of the principles appear to be outweighed by the

advantages gained in presenting the theory so closely associated with the procedures. Excellent notes following the procedures discuss the intricate details involved in the analysis.

The authors regard as "highly unsatisfactory" the plan requiring the student to study by means of preliminary experiments the various characteristics of the elements before beginning their systematic separation. They encourage an understanding of the scheme of analysis of a group prior to actually beginning the analysis. It is felt by some that such an approach may perhaps rob the student of the opportunity he otherwise would have for logically building up the procedure in his own mind, presumably on the basis of experience and information gained in doing preliminary experiments. Certainly it may be contended, however, that the average student in elementary chemistry hardly has a background complete enough or the required time and training to enable him to achieve such an objective to an extent which is very satisfying either to himself or to the instructor. Furthermore, curtailing the preliminary experiments not only provides time for the analysis of additional general unknowns, which is an excellent way of summarizing and integrating the important facts and principles which are inherent in qualitative analysis, but time is then available for the consideration of such valuable topics as the preparation of the sample for analysis and the quantitative estimation of the amounts present in an unknown sample.

The authors retain carefully controlled macro techniques in preference to "semi-micro" methods. The optional use of the centrifuge is proposed, however, in order to eliminate time consuming filtrations, and the size of the unknown sample is limited to 100 mg. Considerable stress is placed on careful manipulation and skill in detecting and estimating small quantities. The notes regarding the sensitivity of the qualitative tests and the facts regarding the separations are exceptionally good. It appears that equation writing and balancing is not stressed to the extent commonly found in texts of qualitative analysis.

On the whole, the text is to be highly recommended to those interested in a complete course in qualitative analysis presented with the objectives and point of view of the authors. It should be of particular interest to those who favor an emphasis on a quantitative estimation in connection with the qualitative identification, and prefer precise macro over "semi-micro" methods.

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CHIEF OF U. S. WEATHER BUREAU TO RECEIVE AWARD FOR SERVICES TO AERONAUTICS

The chief of the U. S. Weather Bureau, Comdr. F. W. Reichelderfer has been chosen as this year's recipient of the Robert M. Losey Award, in recognition of outstanding contributions to the science of meteorology as applied to aeronautics. Presentation was made at a dinner held by the Institute of Aeronautical Sciences in New York on the evening of Jan. 26.

Comdr. Reichelderfer has been head of the Weather Bureau since January, 1939. Previous to that time he had been a meteorological officer in the U. S. Navy. He has been particularly interested in the development of the radiosonde, by which data on upper-air conditions are transmitted automatically from a small sending set attached to feather-weight instruments carried aloft on a small, unmanned balloon.

AUDUBON JUNIOR CLUBS

To create genuine enthusiasm for bird study, and to help your class develop a lasting interest in the out of doors, form an Audubon Junior Club.

Audubon Junior Clubs have been sponsored by the National Audubon Society for 32 years. These clubs have promoted an appreciation of living things on the part of over 6,000,000 children in elementary and secondary schools. In war time it seems more important than ever to teach children to observe, understand and enjoy the familiar birds seen on their own streets, in city parks, and nearby in the country. To watch a bird is to discover the many other animals, plants took upon which it depends for food and shelter. Thus, a knowledge of birds provides an introduction to the whole field of nature study.

Audubon Junior Clubs offer an inexpensive means of obtaining excellent teaching material. A special endowment for Junior Clubs covers over half the cost. Dues of ten cents (10) per child, in groups of ten or more children per school year (September to June), brings the following interesting suplies:

A. For every child
   1. A bird membership button
   2. 6 four-page bird leaflets, by Roger Tory Peterson.
      Junior edition with large type and simplified text for elementary grades.
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   3. 6 full-page color plates of birds described in the leaflets.
   4. 6 outline drawings for coloring (*supplied with Junior edition leaflets ONLY*).

B. For every club

   News on the Wing—club newspaper. To issues each semester.
   Things to Do—a special leaflet packed with practical suggestions for club activities.

C. For clubs of 25 or more members
   Audubon Magazine—three issues each semester.
   The spring term is an excellent time to begin an interest in birds. Enroll now.

The National Audubon Society will gladly send materials at once to any teacher sending dues for 10 or more children. Write to Junior Clubs Department, National Audubon Society, 1006 Fifth Avenue, New York City.

GO TO COLLEGE AT GOVERNMENT EXPENSE

Opportunity to go to college at government expense, and aid in the war effort at the same time, is offered to high school graduates with courses in mathematics, physics or chemistry and some college training or practical experience in the physical sciences.

Qualified applicants for positions as under engineer trainee in radio research work will be paid at the rate of $1440 a year plus overtime during a 24-week training period at the University of Illinois. Pay will rise to $1620 a year plus overtime (approximately 22 per cent of base pay) upon satisfactory completion of the training period. The place of duty will be Dayton, Ohio.

Persons employed in full-time war work of equal skill should not apply. Further information may be obtained from the Seventh U. S. Civil Service Region, New Post Office Building, Chicago, Illinois.